Evolution of entrepreneurial teams in technology-based new ventures

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EVOLUTION OF ENTREPRENEURIAL TEAMS IN TECHNOLOGY-BASED NEW VENTURES

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EVOLUTION OF ENTREPRENEURIAL TEAMS IN TECHNOLOGY-BASED NEW VENTURES

Tatiana Zabara

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CHAPTER 1: INTRODUCTION

1.1. New venture teams (NVTs) in technology-based entrepreneurship

Technology-based entrepreneurship is an influential source of scalable economic growth and major improvements in public health, environmental sustainability, and wealth creation. The mechanisms through which entrepreneurs shape their ventures are often contingent on factors related to the institutional characteristics of the national economy, industry, and most importantly – the entrepreneurs themselves. In this PhD dissertation, we highlight the essential role of the entrepreneurs at the heart of technology-based new ventures – with a specific focus on their experience, disposition and actions. Adopting an interdisciplinary approach to entrepreneurship, we bridge insights from related disciplines, such as social psychology, personality research, management and organizational behavior. By doing so, this dissertation aims at gaining a more fine-grained insight into the role of individuals and teams in entrepreneurial opportunity identification.

The importance of entrepreneurial teams has been widely recognized by research and the popular press. Because the majority of new ventures are started and led by teams, rather than by a single entrepreneur (Kamm, Shuman, Seeger, & Nurick, 1990; Klotz, Hmieleski, Bradley, & Busenitz, 2014), team members' experience and qualifications are important factors for entrepreneurial success (Beckman, 2006; Eisenhardt & Schoonhoven, 1990; Ensley, Pearson, Amason, 2002; Wasserman, 2013). Next to supplying their firm with critical human and social capital, founders shape the initial structures of their organization, which tend to have long-lasting imprinting effects, affecting new ventures' development over time even after all initial founders have left the firm (Baron & Hannan, 2002; Beckman & Burton, 2008; Leung, Foo, & Chaturvedi, 2013). The salient role of teams becomes particularly apparent in high-technology sectors, where the complexity of the business requires an array of technological and commercial capabilities impossible to possess by a single person, as a result of which

technology commercialization becomes increasingly a team sport (Beckman, 2006; Chowdhury, 2005; Mustar & Wright, 2010). Given the typically small size of entrepreneurial teams, their high degree of interdependency and joint decision-making, the organizational and team levels of analysis often coincide, with the latter allowing to capture pertinent competences that determine new venture's success (Beckman, Burton, & O'Reilly, 2007; Forbes, Borchert, Zellmer-Bruhn, & Sapienza, 2006; Penrose, 1995), and making these teams a promising and compelling topic to research.

Although quality of the team is critical to investors (Boeker & Wiltbank, 2005; Clarysse & Moray, 2004; Gimmon & Levie, 2010) and for the overall success of the new firm (Beckman & Burton, 2008; Beckman, Burton & O'Reilly, 2007), we know surprisingly little about how teams emerge and evolve, and how they affect firm performance over time. Extant research on new venture teams has produced a large number of valuable insights, focusing on the effects of various human and social capital characteristics on team processes and organizational outcomes (for recent review, see Klotz et al., 2014). However, topics related to team formation and evolution have been widely under-studied and many research questions remain unanswered. Specifically, questions related to how teams evolve and what determines their founding mode remain open to date. This is particularly intriguing given that a team's composition of knowledge and experience is considered to be one of the main drivers of new venture success (Colombo & Grilli, 2010; Eisenhardt & Schoonhoven, 1990). Yet new ventures often experience a number of constraints that may prevent them from developing a most optimal team. Deliberate or unconscious in their nature, these constraints may take place already at the very inception of a new firm and may persist during its further development. Therefore it is important to understand where they come from and how they can be overcome. Specifically, we need a more fine-grained understanding of what drives a particular founding mode of a team and what influences its development over time.

Against this backdrop, the present PhD dissertation aims to gain a deeper understanding of the role of entrepreneurial teams, focusing specifically on their emergence and evolution. To do so, we first perform a systematic literature review to map existing work, to identify existing gaps and avenues for future research (Chapter 3). In a unique longitudinal data set of Flemish technology-based new ventures, we then aim to address these research gaps (Chapters 4 and 5). In this introduction, we begin by providing definitions that we will use throughout this dissertation. We then introduce the overall theoretical framework and present a summary of the three papers included in this dissertation: one systematic review (Chapter 3) and two empirical studies (Chapters 4 and 5).

1.2. Defining NVTs in technology-based new ventures

The present dissertation focuses on new venture teams within high-technology sectors, in which entrepreneurial opportunity is fostered through innovations in science and engineering. By doing so, we aim to address new ventures that exhibit the ambition and potential to grow and succeed. While technology-based new ventures are not representative of the entire population of start-ups, they form an important subgroup, particularly with regard to their contribution to the respective national economy, job creation and innovation (Almus & Nerlinger, 1999; Audretsch, 1995). Due to the critical challenge of linking technological expertise with market-related capabilities, these ventures are typically founded by teams (Roberts, 1999) whereby the question of retaining and updating highly skilled human capital plays a particularly pertinent role, making technology-based new venture teams an interesting context to study evolution and performance effects of new venture teams.

In this dissertation, we distinguish between *founding teams* and *new venture teams*. In line with prior research, we define founding team as a group of entrepreneurs who were involved in new venture's legal incorporation (De Jong, Song, & Song, 2013). The term new

venture team, in contrast, refers to both founding teams and teams comprising subsequently hired managers. Throughout this dissertation we will use the terms new venture team, entrepreneurial team, and start-up's management team interchangeably to describe "the group of individuals that is chiefly responsible for the strategic decision making and ongoing operations of a new venture" (Klotz et al., 2014, p. 227).

1.3. Overall framework of this dissertation

The main objective of this PhD dissertation is to provide a deeper insight into the issues related to the evolution of entrepreneurial teams. Providing an in-depth account of multiple team characteristics, while acknowledging the dynamic nature of new venture teams, will substantially improve our understanding of the role of teams in entrepreneurial success and contribute to a number of related research fields, including entrepreneurship, management, organization and strategy. In addition, this dissertation is also designed to have a number of practical implications, as it addresses important issues of team staffing and development. It aims to shed light onto important questions relevant for both scholars and practitioners: "Why do management teams look the way they do?" and "Is it better to start up with a fully developed team of experts (which might be costly both financially and in terms of coordination) or is it better to start up with a relatively small and homogeneous team and acquire additional human capital as a new venture evolves?"

Although scholarly interest in new venture teams is relatively new, the field generated a large amount of work, covering numerous issues related to team experience (e.g., Colombo & Grilli, 2010; Gruber, 2010), diversity (e.g., Amazon, Shrader, & Tompson, 2006; Eisenhardt & Schoonhoven, 1990), team functioning/ processes (e.g., Ensley & Hmieleski, 2005; Ensley, Pearson, & Pierce, 2003) and emergent states (e.g., Brinckman & Hoegl, 2011; Chowdhurry, 2005). In order to be able to navigate through this large and wide-spread body of work and to

identify the open research questions specifically critical to teams in high-technology ventures, there was a need of an overview of the extant research. To provide such an overview, which would allow us to identify research gaps and to formulate promising and compelling propositions, we conducted a systematic literature review with a specific focus on high-technology new ventures as represented by academic spin-offs. Although, academic spin-offs (ASOs) do not represent the entire population of technology-based start-ups, they constitute an important proportion of innovative technology-based new ventures (Rasmussen, Mosey, & Wright, 2011). As such they face similar concerns as their independent counterparts that commercialize novel and often disruptive technologies. Therefore, the insights generated from the ASO context can be transferred and applied to the wider context of technology-based start-ups. Furthermore, ASOs are typically founded by teams (Bonardo, Paleari, & Vismara, 2010; Mustar & Wright, 2010), which makes them particularly interesting to examine issues related to entrepreneurial teams. Chapter 3 of this PhD dissertation is the result of a large-scale systematic review[1] of studies on teams in academic spin-offs published in peer-reviewed journals between 1980 and 2015. This review summarizes the current state of the art[2] and highlights existing research gaps. The most prominent research gaps that were identified within this literature review included current lack of understanding of (a) team formation and (b) compositional dynamics within teams. The subsequent chapters of this PhD dissertation are two empirical studies that aim at filling these gaps.

First, studies on new venture teams predominantly focus on firm performance and other indices of entrepreneurial success, whereby little is known about the origins of teams and their

[1] This review was conducted as part of a collaboration project with Dr. Iro Nikiforou, Prof. dr. Bart Clarysse, and Prof. dr. Marc Gruber. The review process was a team effort, to which I have significantly contributed. The resulting paper (part of this PhD as Chapter 3) was published in the *Academy of Management Perspectives*, reference: Nikiforou, I., Zabara, T., Clarysse, B., & Gruber, M. (2018) The Role of Teams in Academic Spin-Offs. *Academy of Management Perspectives*, *32*(1), 78-103.

[2] Existing reviews on the role of entrepreneurial teams (e.g., Klotz et al., 2014) cover a wide range of team-related themes, yet do not focus on the specific issues related to technology-based entrepreneurship. Given the richness of the field, there was a need to synthesize existing research on teams in academic spin-offs.

configuration. Lack of these insight is surprising given that founding conditions have long-lasting imprinting effects, which are known to influence new ventures' development and performance over time (Marquis & Tilcsik, 2013; Simsek, Fox, & Heavey, 2015). Understanding how entrepreneurial teams emerge and what drives heterogeneity in their initial design is important both for theory and practice. A deeper insight into the forces governing the initial structural choices may help to overcome biases and increase the change for new venture success. In Chapter 4, we use our rich dataset of career histories and demographics of founders in Flemish technology-based new ventures to examine the role of lead founder's personality traits in assembling and structuring the founding team[3]. By delving into the micro-foundations of founding team structures and focusing on the entrepreneurs' individual biases, we aim to contribute to the important question of why management teams look the way they do and why there is high degree of heterogeneity with regard to how founders start their firms.

Second, existing research on entrepreneurial teams, along with the general team research, has been criticized for treating teams as static entities, whereby their characteristics are linked to firm performance, disregarding compositional changes that occurs within these teams (e.g., Ferguson et al., 2015; Guenther et al., 2015). Because new ventures' human capital constitutes their most critical asset, changes to founding teams are crucial for new firms' success. Understanding the drivers of compositional change is particularly important for practitioners, while at the same time there is a need for theory synthesis. Following recent calls for a more dynamic approach to team composition (Mathieu, Tannenbaum, Donsbach, & Alliger, 2014), we focus on compositional change within new venture teams. In Chapter 5, we use our unique longitudinal dataset of Flemish technology-based new ventures to examine the antecedents of new managerial hire in technology-based new venture team[4]. We argue that the

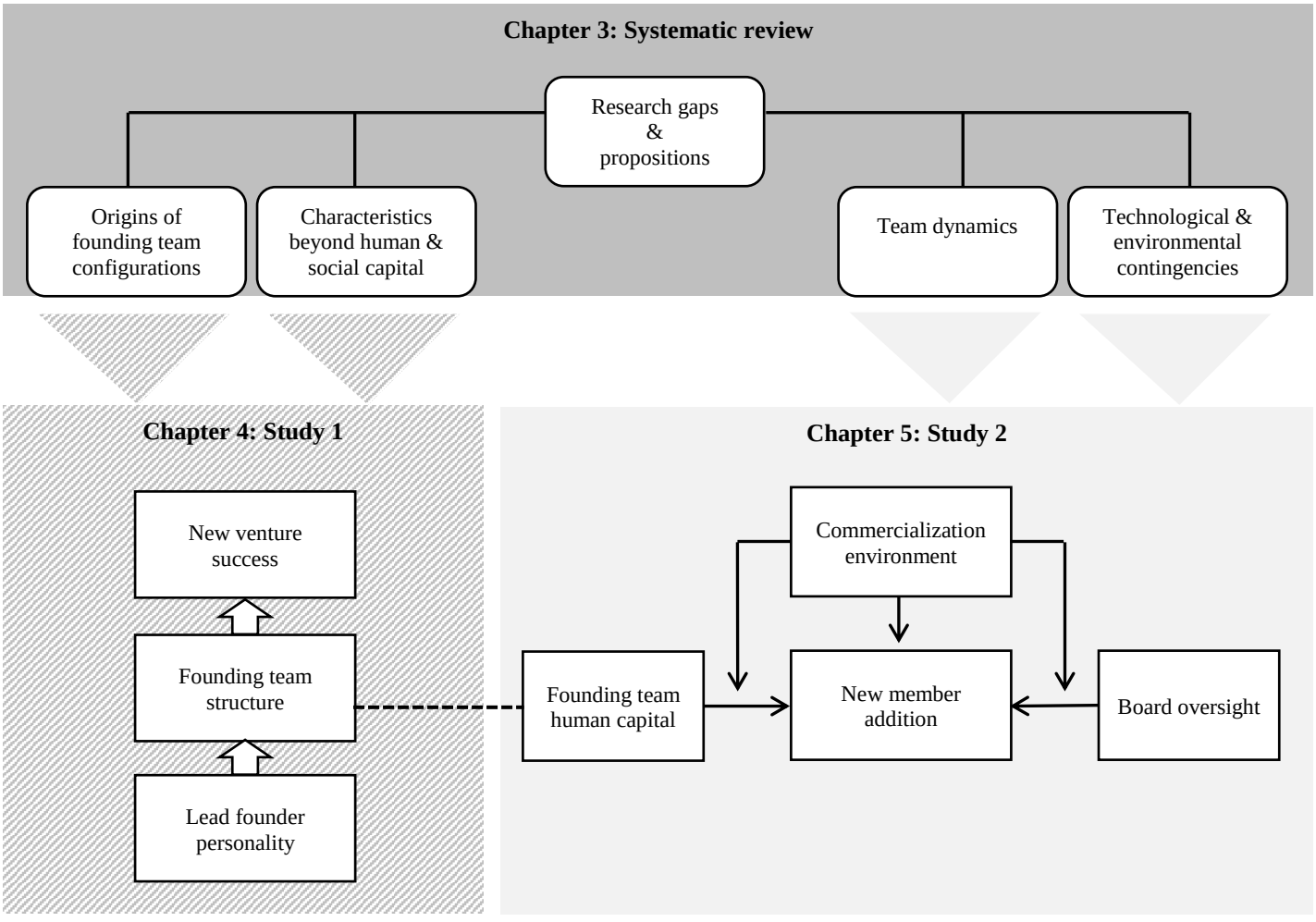
[3] This paper is co-authored with: Prof. dr. Boone, Prof. dr. van Witteloostuijn, and Prof. dr. Clarysse. It aims to be submitted to the *Journal of Business Venturing*

[4] This paper is co-authored with: Prof. dr. Boone, Prof. dr. van Witteloostuijn, and Prof. dr. Clarysse. It has been submitted to the *Strategic Entrepreneurship Journal*.

antecedents of new member addition can be traced to the attributes of team, organization and environment in which new ventures operate. We further examine and discuss the relative importance of these attributes.

Figure 1.1 represents the overall research framework of this dissertation, illustrating how research gaps and propositions derived from the systematic review (Chapter 3) lead to the subsequent empirical chapters, in which we attempt to fill these gaps. The two empirical studies (Chapter 4 and Chapter 5) are also interrelated, as they address different stages of the founding team evolution. In the following sections, we provide a short summary of each of the three papers, the systematic review and the two empirical studies.

Figure 1.1. Overall framework of this dissertation



1.4. Overview of the papers

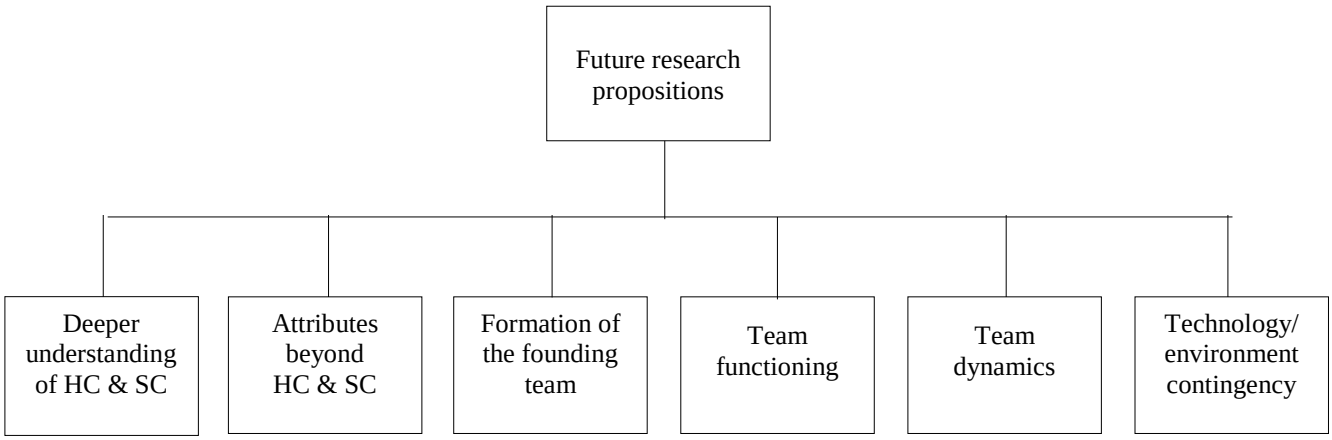
1.4.1. Chapter 3: The role of teams in academic spin-offs

Academic spin-offs (ASOs) represent a small but economically significant proportion of high-tech new ventures. Although, originating from a historically non-commercial environment, academic new ventures tend to be different from their independent counterpart in a number of aspects (Colombo & Piva, 2012), they are faced with similar challenges at the core of which is the need to synergize technological and business competences in order to successfully commercialize novel and potentially disruptive technologies (Rasmussen, Mosey, & Wright, 2011). These challenges may involve potential lack of relevant commercial skills and industry experience, as well as the need to hire new managers in an attempt to overcome this shortcoming. New professionals may add relevant managerial know-how, yet these additions may also be detrimental as differences between managers and engineers with regard to their mindset and identities may be large.

The purpose of the Chapter 3 of this PhD dissertation is to provide a systematic review of existing wok on teams in ASOs that would enable an overview of pertinent common themes, as well as to identify research gaps. Although the specific focus of this literature review is on the academic spin-offs, we are certain that a large number of generated insights also applies to the independent technology-based start-ups. We carefully analyze, map and discuss this body of work in order to make it readily accessible to researchers and outline a number of interesting paths for future research at the intersection of ASO and entrepreneurial teams. We find that the majority of reviewed studies has focused on the human capital (HC) and social capital (SC) endowments of academics and surrogate entrepreneurs forming the ASO team, while much less attention has been directed to issues surrounding team formation and evolution, and only a handful of studies focused on team functioning, such as knowledge-sharing and conflict. Based on this critical assessment of the status quo, we identified several research gaps and

articulated promising avenues for future research, as illustrated in Figure 1.2. We aim at filling some of these gaps in the follow up chapters of this PhD dissertation.

Figure 1.2. Chapter 3: Future research propositions



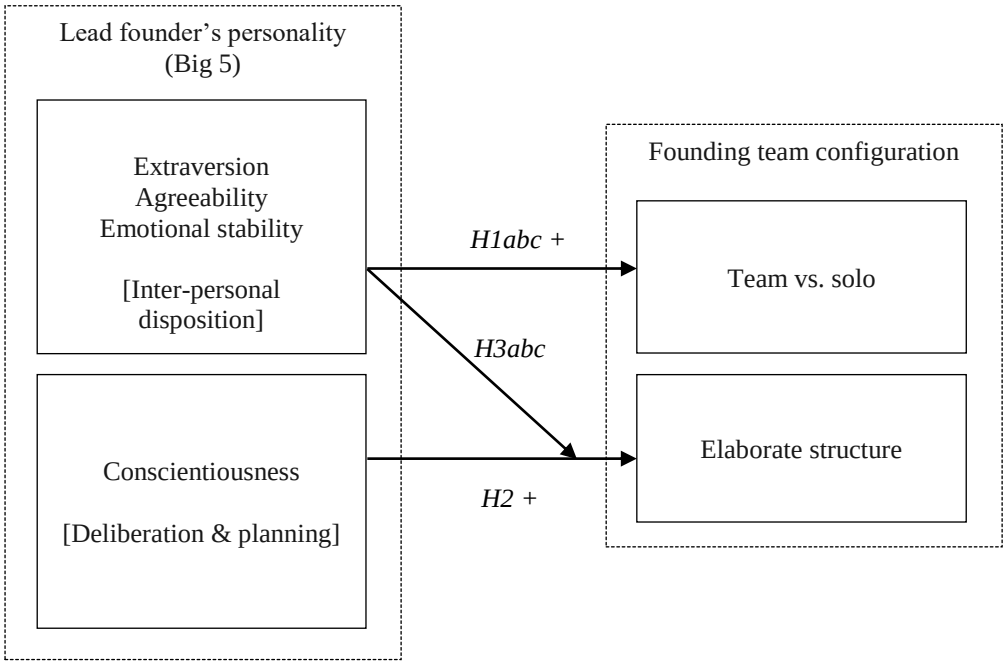
1.4.2. Chapter 4: Micro-foundations of organizational blueprints: The role of lead founder's personality

Founding team structures have been found critical for new ventures' development and success as they provide a framework for entrepreneurs to combine and channel their efforts to achieve organizational goals, but also because once established they tend to be long-lasting and difficult to change (Beckman & Burton, 2008; Leung et al., 2013). For instance, scholars reported that new ventures founded by teams, as opposed to lone entrepreneurs, have higher survival rates (Aspelund, Berg-Utby, & Skjevdal, 2005), and that founding teams with higher levels of structuring are more likely to grow (Sine et al., 2006), obtain venture capital (Beckman & Burton, 2008), and to achieve initial public offering (Beckman et al., 2007). Teams as opposed to a lone entrepreneur enjoy access to more human and social capital resources (Hambrick & D'Aveni, 1992), and developed structures help new firms to overcome liabilities of newness (Stinchcombe, 1965). While a majority of new ventures start-up with fairly homogenous founding teams (Klotz et al., 2014; Ruef, Aldrich, & Carter, 2003), there is a high variability between new ventures with regard to how they structure their founding teams. This leads to an interesting, yet understudied question – what influences founders' preferences toward one or another (potentially more successful) design? In other words, what determines new ventures' successful blueprint and, consequently, why do organizations and their management teams look the way they do?

To answer this question, prior research focused on the institutional context of a new venture creation – by comparing university spin-offs with independent technology-based start-ups (Colombo & Piva, 2012; Ensley & Hmieleski, 2005) – and at the sociological mechanisms behind founding team formation (Ruef et al., 2003). These studies have highlighted the importance of the lead entrepreneur in making a core decision of *whether* to recruit a team and *whom* to recruit. Yet do date, this role has not been empirically examined. Chapter 4 of this

PhD dissertation aims to contribute to this line of research by elucidating the role of lead founder's personality in forming a founding team, in a way that facilitates the long-term success of a nascent organization. Using our rich fine-grained data on founders' functional positions and career histories, we find that personality traits affect different aspects of the founding team structure, each of which are known to facilitate new ventures' long-term success. *Extraversion, agreeableness* and *emotional stability* reflect individuals' interpersonal disposition and are associated with founding with a team. *Conscientiousness* reflects individuals' deliberation and planning and is important for the structural elaboration of the founding team. Figure 1.3 depicts the research model of this chapter.

Figure 1.3. Chapter 4: Research model



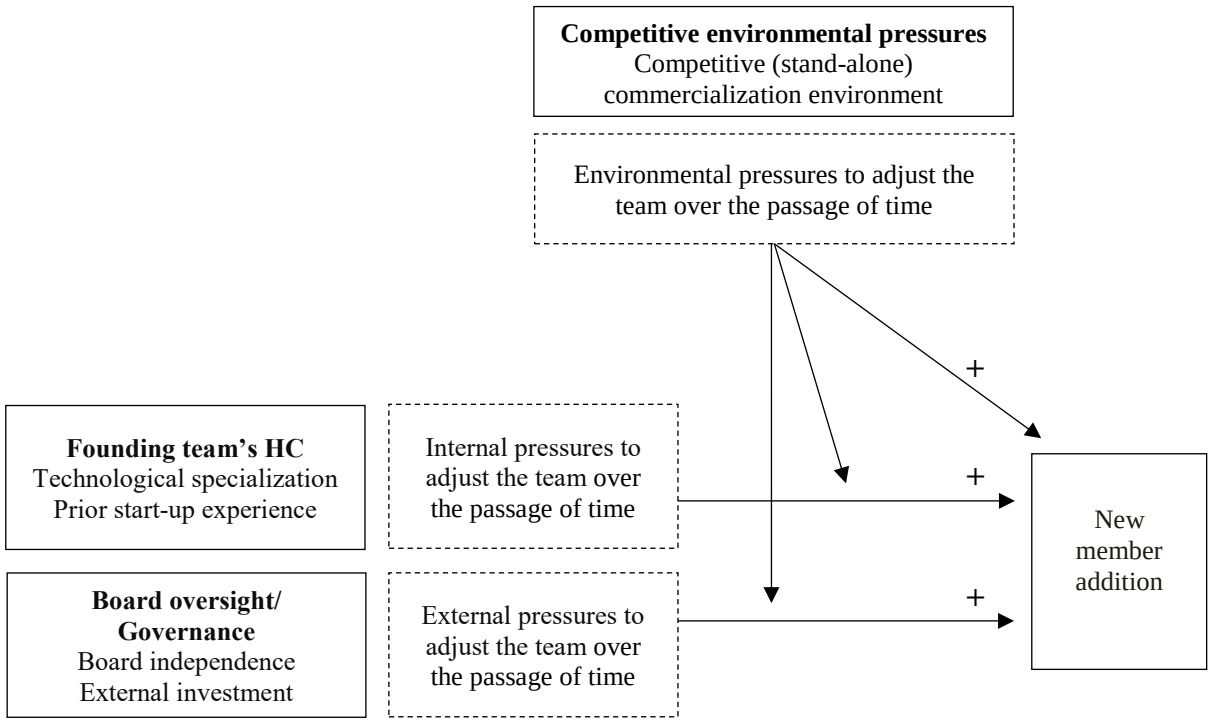
1.4.3. Chapter 5: Expanding the circle: Antecedents of a new managerial hire in technology-based new venture teams

New ventures are typically founded by a group of friends or colleagues (Klotz et al., 2014; Ruef et al., 2003) whose knowledge, skills and charisma become the major source of new firms' initial human capital (Beckman & Burton, 2008; Eisenhardt & Schoonhoven, 1990). Over the course of time, new ventures need to professionalize their founding team by hiring new managers as the venture evolves and outgrows capabilities of its initial founders (Boeker & Karichalil, 2002; Chang & Shim, 2015; Wasserman, 2003). As the original founders may not possess the requisite skills to manage a firm growing beyond its founding stage, new managers are needed to reduce the misfit between founders' capabilities and changing organizational demands. This first manager-level hire is an important milestone in a life of a new venture as it sets the course towards transition from a small, typically unstructured venture managed by a rather informal entrepreneurial group to a fully developed organization led by a professional management team. Despite a number of studies devoting their attention to the evolution of founding teams, we still know surprisingly little about when firms are likely to reach this milestone and what factors influence its completion.

Extant studies have generated a wide range of interesting insights (e.g., Boeker & Wiltbank, 2005; Beckman & Burton, 2008; Feguson et al., 2016; Ucbasaran et al., 2003; Wasserman, 2003; 2017), with, however, little integration effort made up to now. Existing findings are dispersed over different literature fields, using different theoretical lenses, different levels of analysis, and (in some cases) datasets that do not allow for fine-grained hypotheses testing. The purpose of the Chapter 5 of this PhD dissertation is to integrate existing findings on antecedents of new managerial hires in entrepreneurial teams, to examine their relative importance and to provide additional insights. We do so with a specific focus on growth-oriented technology-based start-ups, as these ventures are typically started by teams in

which capability development proves particularly important (Gruber, MacMillan, & Thompson, 2008; Mustar & Wright, 2010). Utilizing our unique longitudinal data on 148 Flemish technology-based new ventures, we find that new ventures' likelihood to hire new managers depends on multi-level forces related to the *founding teams' human capital*, *board oversight*, and *commercialization environment*. Figure 1.4 illustrates the research model of this chapter.

Figure 1.4. Chapter 5: Research model



CHAPTER 2: METHODS

In the spirit of the open science movement (Honig et al., 2018; van Witteloostuijn, 2016), this chapter provides a detailed overview of the data collection and the dataset construction processes. The aim is to promote transparency, but also to acquaint the reader with the dataset used in this dissertation, including its strengths and weaknesses. In the following sections, we first describe the type of data that was collected for this dissertation. We then, describe in detail the methods of the review study (Chapter 3) and the datasets used in the two empirical studies (Chapters 4 and 5).

2.1. Data collection

The purpose of this PhD dissertation is to examine the role of entrepreneurial teams in the development and performance of technology-based new ventures. First, this requires a thorough assessment of the status quo within the extant research. We therefore, performed a large-scale systematic literature review, including 593 papers published in peer reviewed journals since 1980. Based on this review, we were able to identify prominent literature gaps, which we addressed in the two subsequent empirical studies. Second, studying the role of teams in technology-based entrepreneurial process requires extensive organizational, team-based and individual data on innovative growth-oriented technology-based new ventures. Because this type of data is not readily available, a key part of this dissertation was the construction of an extensive longitudinal database, which encompassed yearly organizational and financial information on 169 Flemish technology-based innovative growth-oriented start-ups and the detailed demographic data on 382 founders and 98 subsequently added managers. In the following sections, we first describe the methods used in the review study (Chapter 3). Then, we describe in detail the dataset used in the two empirical studies (Chapters 4 and 5).

Table 2.1. Overview of the collected datasets

Chapter 3 (Review)		Chapter 4-5 (Empirical studies)	
Reviewed papers	N=593	Firms	N=169
Final dataset	N=43	Founders	N= 382
		New team members	N=98

2.2. Chapter 3: Methods

We conducted a systematic literature review of studies that examined the role of teams in academic spin-offs for the period between 1980 and 2016. We chose 1980 as the starting point of our review, because the enactment of the Bayh-Dole Act in 1980 increased the incentives for academic science commercialization (Link, Siegel, & Bowman, 2007; Siegel, Waldman, & Link, 2003) and initiated increasing scholarly interest in this phenomenon. We searched the Web of Science database for studies containing the terms "team(s)", "founders" or "entrepreneurs" and a variety of keywords that we generated in order to capture academic spin-offs. The full list of keywords is provided in Table 2.2. Our initial search generated 593 studies. We reviewed each of the 593 papers to identify those studies that met our inclusion criterion: research that deals with both (1) teams and (2) academic spin-offs in a non-trivial manner. For instance, some papers only touched upon the notion of team and, thus, can hardly be considered as research that is focused on the subject of the present study. In this regard, studies that simply mention the words "team", "spin-off" (or related words) and did not elaborate on these concepts were eliminated from our review. In addition, we eliminated studies that examined teams different than founding teams or top management teams, except for the studies that examined other types of teams (e.g., board of directors) in relation to founding or top management teams. This process generated 40 studies. Furthermore, we added 3 papers (Colombo & Piva, 2008; Franklin et al., 2001; Heirman & Clarysse, 2004) that we knew were

relevant to our study but did not show up in our search, giving us a total sample of 43 studies that formed the basis for our literature review.

Table 2.2. List of keywords

To capture teams	To capture academic spin-offs
Team / founders / entrepreneurs AND	Academic spin-offs/ spin-outs/ start-ups/ ventures/ firms
Team / founders / entrepreneurs AND	University spin-offs/ spin-outs/ start-ups/ ventures/ firms
Team / founders / entrepreneurs AND	Research spin-offs/ spin-outs/ start-ups/ ventures/ firms
Team / founders / entrepreneurs AND	Science spin-offs/ spin-outs/ start-ups/ ventures/ firms
Team / founders / entrepreneurs AND	Science/ research/ academic/ university commercialization
Team / founders / entrepreneurs AND	Science/ research/ academic/ university incubator
Team / founders / entrepreneurs AND	Science/ research/ academic/ university park
Team / founders / entrepreneurs AND	Academic technology transfer/ TTO
Team / founders / entrepreneurs AND	University technology transfer/ TTO

2.3. Chapter 4 and 5: Database construction

At the basis of the empirical database construction was the initial dataset of Flemish technology-based innovative start-ups, which comprised very detailed information on NVs firm-level information including: founding year, sector, type of the business model, product-orientation, patent, board, and investment (see Table 2.1 for the full overview of variables). This dataset has been constructed by Prof. dr. Bart Clarysse[5] and Prof dr. Robin de Cock[6] in collaboration with the Flemish Agency for Innovation by Science and Technology (IWT)[7],

[5] We would like to thank Prof. dr. Bart Clarysse for sharing this data set

[6] We would like to acknowledge Prof dr. Robin de Cock who has initiated and was chiefly responsible for the collection of the initial dataset, which we complemented by a new wave of data collection that resulted in our final database

[7] At the time of the initial data collection (between 2009 and 2015), IWT was a governmental agency aimed at supporting innovation in Flanders, both within academia and industry. In 2016, it merged with The Research Foundation Flanders (FWO) – a Flemish public research council that aims at supporting scientific research.

which has helped to identify the population of innovative technology-based start-ups, provided their contact information and endorsed participation in the data collection process[8]. The overall initial dataset comprised 169 new ventures (1,006 annual observations) founded between 2006 and 2013. As the list of newly founded firms were yearly added, the dataset resulted in an unbalanced panel dataset, with the last new firms update following in 2014 (firms founded in 2013) and the last data collection round in 2015. While this dataset provides rich longitudinal information on entrepreneurial firms, it was not designed for team-demography research. It lacked fine-grained individual and team-level data and hence did not allow us to test our hypotheses. Therefore, additional data collection was performed to create a comprehensive dataset of demographic characteristics of all founders and subsequent managers for each corresponding year of observation.

The additionally collected data comprises 382 founders of 169 firms and 98 new managers for which multiple sources were used. We began the data collection process by cross-checking the organizational information about each of the start-up in the initial dataset using the BELFIRST database and the Belgian business register (*Staatsblad*). This information included: status (i.e., active vs. closed), legal situation, founding date, contact details, and names of founders and officers (where applicable). We also recorded new more detailed information that helped us link the initial dataset with other existing data sources. This information included: enterprise registration number, Standard Industrial Classification (SIC) numbers, starting capital, and whether the firm is a university spin-off. We then used founders' career histories to construct a database of each founder's demographic and career-related information using secondary data sources (e.g., LinkedIn, Bloomberg, firms' websites, and press releases), which we also

[8] We refer to Appendix 2.4.1 at the end of this chapter for more detailed information on the data collection methods of the initial dataset.

supplemented by the primary data-collection (e.g., emails and interviews with the founders), where secondary data could not be obtained. Based on the individual-level detailed raw data, we constructed team-based variables.

Merging the two datasets resulted in a unique longitudinal database that combines yearly organizational data on entrepreneurial firms, complemented by fine-grained information about founders and subsequently hired managers – including their education, age, prior functional experience (with up to three former positions), company affiliation and shared work and education experience. The advantage of this dataset is that it follows each firm since its legal founding. Its longitudinal nature allows us to keep track of the changes in firm and team-level characteristics, while accounting for the effects of founding conditions. Hence, it fits well with the objective of this dissertation to study the evolution of the entrepreneurial teams. Table 2.3 provides the full overview of the data within the two merged datasets. In the following sections, we first describe the overall dataset, and subsequently the datasets used by each of the two empirical studies.

Table 2.3. Dataset construction

	Initial dataset (169 firms)	Data collected as part of this PhD dissertation (169 firms; 382 founders; 98 new managers)
Environment-level:	Sector	SIC codes Patent effectiveness Complementary assets Commercialization environments
Firm-level:	Founding year Product vs. Service vs. both B2B vs. B2C vs. both	Enterprise registration number University spinoff Corporate spin-off
	Board Advisory board Investment board Board size External board members	Board independence External investment Starting capital
	Venture capital acquisition Government investment Business angels' investment	

	Patent Number of patents Family business	
Team-level:	Team size Team exit Team member addition	Confirm founding team size Confirm founders' names Confirm team size Confirm team exit Confirm team member addition Education diversity Functional role at founding diversity Functional role at founding breadth Dominant functional experience diversity Functional experience breadth Elaborate structure Prior commercial experience (years) Prior entrepreneurial experience Technological specialists archetype
Individual-level:	Lead founder's: Commercial experience (years) Personality Past start-up experience	For each team member: Year of birth Gender Level of education Field of education Prior entrepreneurial experience Serial entrepreneur Functional role at founding Functional role at each year Past job functional role 1 (last job) Past job functional role 2 (second last job) Past job functional role 3 (third last job) Dominant functional experience Prior company affiliation (company name) Prior commercial experience (years) confirmed Data availability

2.3.1. Sample description

This section deals with the descriptive statistics of the sample. We begin by providing an overview of some basic organizational characteristics of the 169 technology-based new

ventures in the overall dataset, summarized in Table 2.4. About 54% of the firms in our sample were founded to commercialize a product, approximately 24% commercialized services, and around 22% to do both. A large share of new ventures developed their products and services to market to other businesses, in a business-to-business model (61%). A smaller share targeted end-consumers (32%), while a very small share targeted both (7%). With regard to the industry sectors, the largest share of new ventures operated within Business services (32%), ICT (20%), and Biotech/ medical (14.8%) sectors. Others are distributed among industries related to Energy, electricity and electric devices, Construction and maintenance, and the Standard products for people's and animals' needs. About 24% of our sample are university spin-offs[9], and approximately 14.8% of the ventures in our sample have had a patent at the time of new ventures' founding. Only 3% of all ventures have received venture capital at the time of founding, while 10% have obtained funds from business angels. Around half of the new ventures had a board, and about 23% had an external board at the time of founding.

Table 2.4. New ventures' organizational characteristics at founding

Commercialization orientation	Total	%
Product	92	54.4
Service	40	23.7
Hybrid	37	21.9
Total	169	100

Business model	Total	%
Business-to-business	103	61
Business-to-consumer	54	32
Business-to-business-and-consumer	12	7
Total	169	100

[9] We performed a number of tests to see whether the university spin-offs significantly differ from the rest of the firms in our sample. The descriptive statistics and the two-group mean comparison tests are summarized in the Appendix 2.4.2.

Industry sector	Total	%
Business services	54	32
ICT	34	20.1
Biotech/ medical	25	14.8
Energy/ electricity/ electric devices	21	12.4
Construction/ maintenance	11	6.5
Other*	16	9.5
missing	8	4.8
Total	169	100

* Standard products for people's & animals' needs

Other characteristics	Total	%	N
University spin-offs	41	24.6	169
Patent at founding	25	14.8	169
VC funds at founding	5	3.1	159
BA funds at founding	16	10	159
Board at founding	77	47.8	161
External board at founding	37	23.3	159

Table 2.5 summarizes some basic characteristics with regard to new ventures' founding teams. The founding team size ranges between 1 and 7 members, with a mean size of 2.2 (see Figure 2.1 for the distribution of founding team size). Assessing the founding team composition, with regard to its functional role structure (Figure 2.2) and its functional experience (Figure 2.4), we observe a large homogenous group: at founding a large group of firms has only one functional role (typically CEO) and only one prior functional experience. This may be caused by the fact that 30% of new ventures in our sample are founded by a solo founder. We therefore also provide team diversity distributions for a sub-sample of new ventures founded by teams. Although the average number of functional roles and prior functional experience is higher for this subset of firms, it still remains fairly low with the majority of founding teams having two functional roles (typically limited to a CEO and a technological function) and with the majority of teams having prior experience in one functional domain. This resonates with the common finding that new ventures are typically founded by groups of friends, relatives and former colleagues who often share similar backgrounds and experiences (Klotz et al., 2014; Ruef at

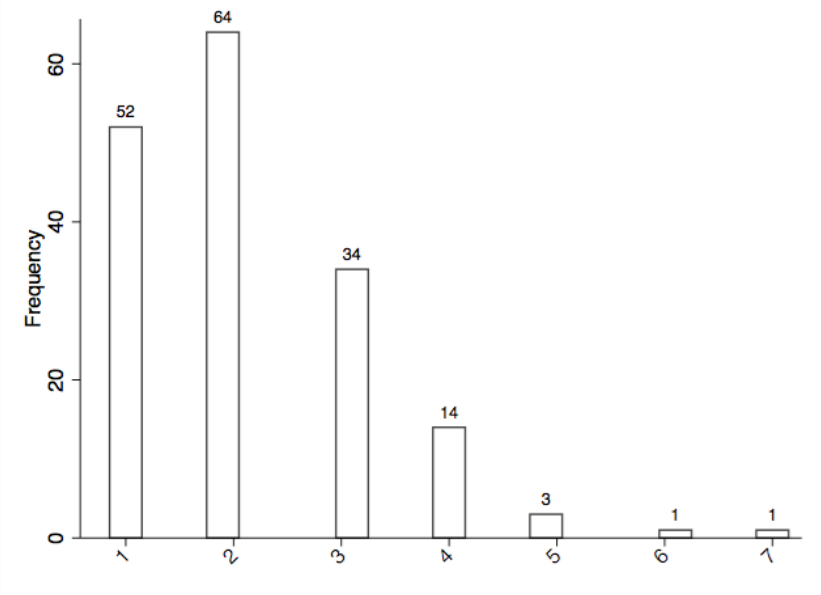
al., 2003). It is also interesting to note that a very small number of teams has no prior functional experience (functional experience breadth is 0).

Table 2.5. New ventures' founding team characteristics

	Measure	N	Mean	Std. Dev.	Min.	Max.
FT size	Count	169	2.17	1.11	1	7
FT role breadth[10]	Count	161	1.66	.78	1	4
Team-based subsample	Count	112	1.92	.78	1	4
FT experience breadth	Count	149	1.73	.97	0	4
Team-based subsample	Count	104	1.97	1.02	0	4

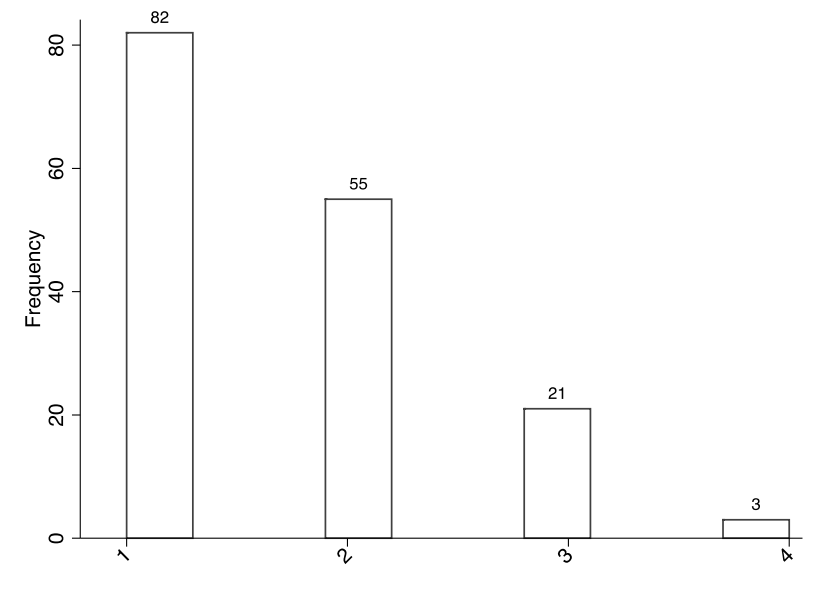
[10] The detailed description of how founding team role breadth and experience breadth variables were assessed can be found in Appendix (2.4.2)

Figure 2.1. New ventures' founding team size



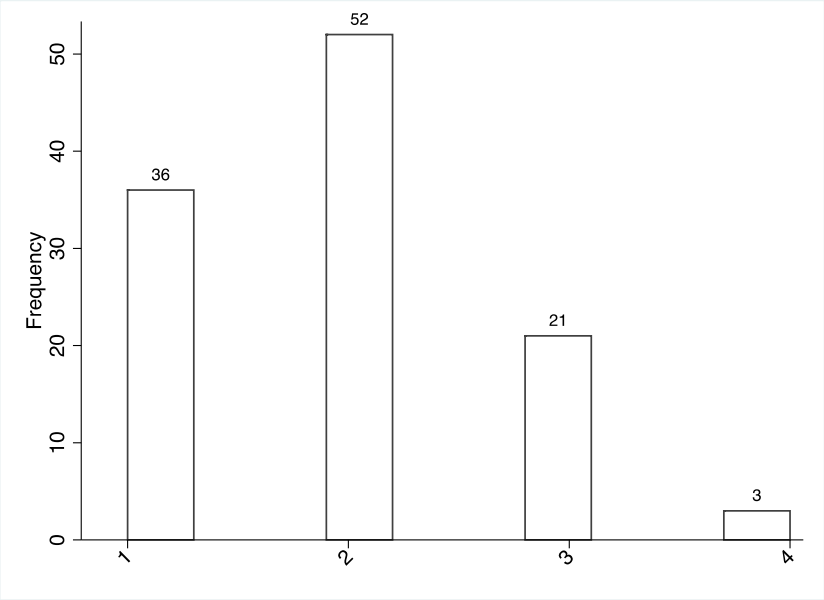
N=169

Figure 2.2. Founding teams' functional role breadth



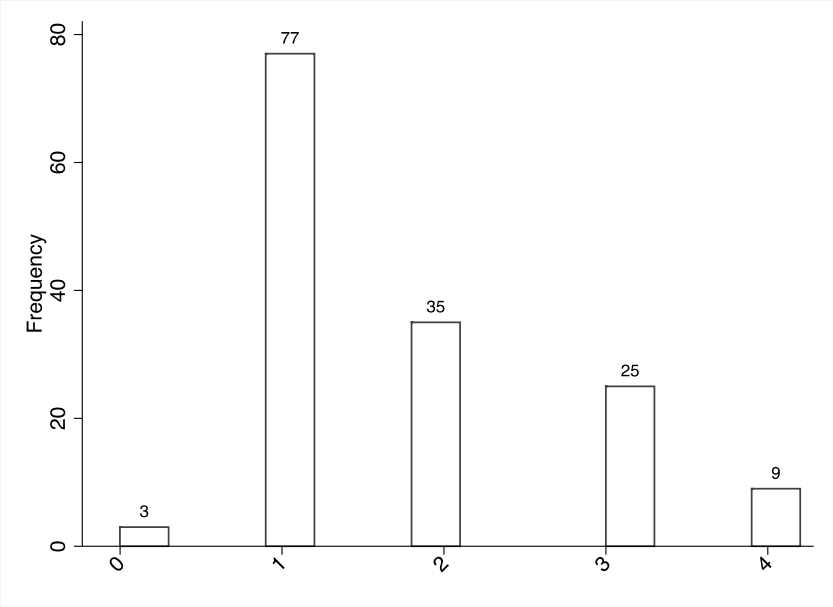
N=161

Figure 2.3. Founding teams' functional role breadth: Subset of team-based NVs



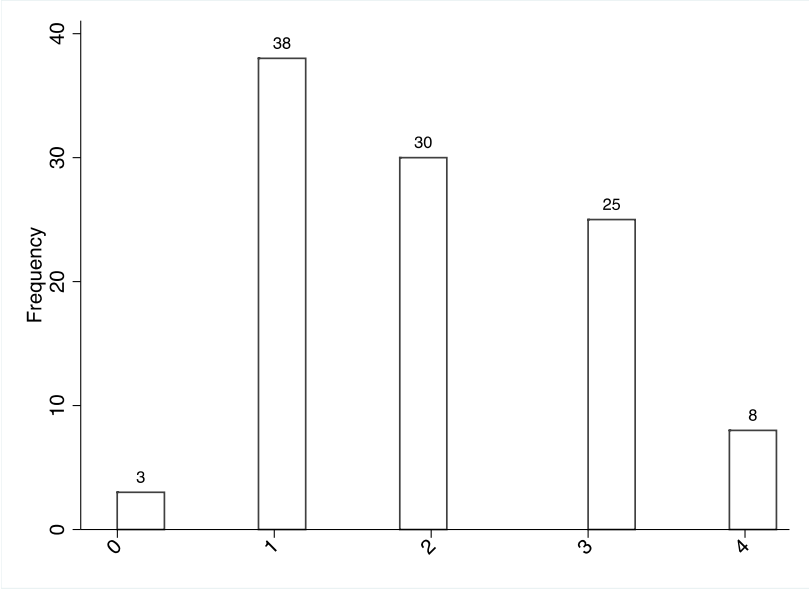
N=112

Figure 2.4. Founding teams' functional experience breadth



N=149

Figure 2.5. Founding teams' functional experience breadth: Subset of team-based NVs



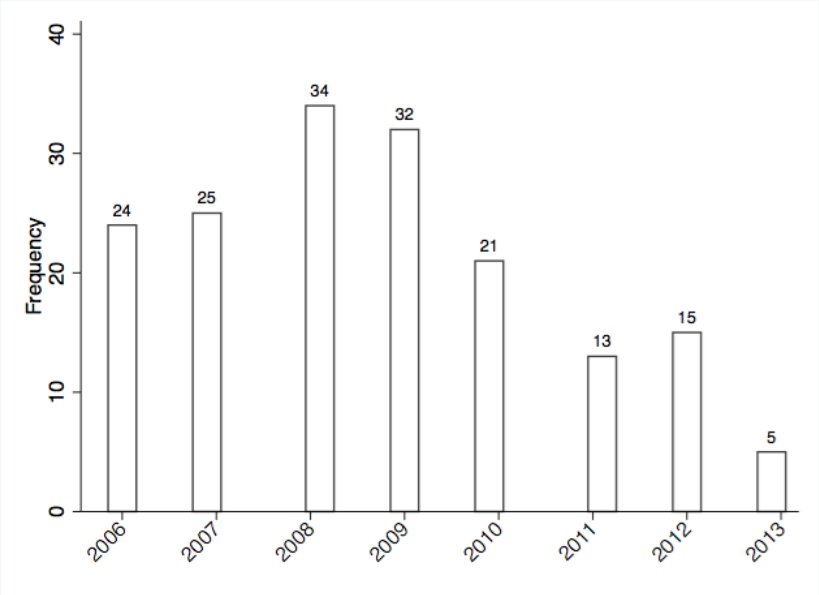
N=104

Table 2.6 presents an overview of some essential time-variant characteristics of our dataset. On average, new ventures were 6.3 years old at the moment of the last data collection round (see Figure 2.6 for the distribution of new venture age and years of founding). During the overall data collection period, 31 (17%) of the firms in our sample ceased their existence. The mean age of failed firms was 6.74, ranging between 3 and 9 years (Figure 2.7). Around 20 firms (12%) have received venture capital investment at some point of time, with the mean age of 7 years at the time of the first receipt of VC funds (Table 2.8). Also, 20 firms (12%) have received business angels' investment (BA) at some point of time, with the mean age of 6.95 years at the time of the first receipt of the BA funds (Table 2.9).

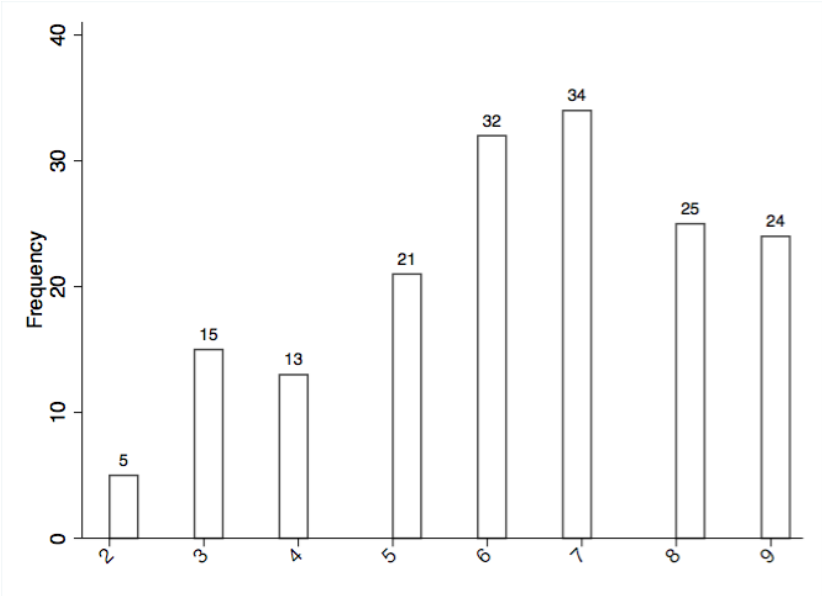
Table 2.6. New ventures' time-varying characteristics

	Measure	N	Mean	Std. Dev.	Min.	Max.
Age	Year	169	6.26	1.93	2	9
Failure age	Year	31	6.74	1.67	3	9
VC age	Year	20	7	1.62	4	9
BA age	Year	20	6.95	1.70	3	9

Figure 2.6. Founding year and new ventures' age

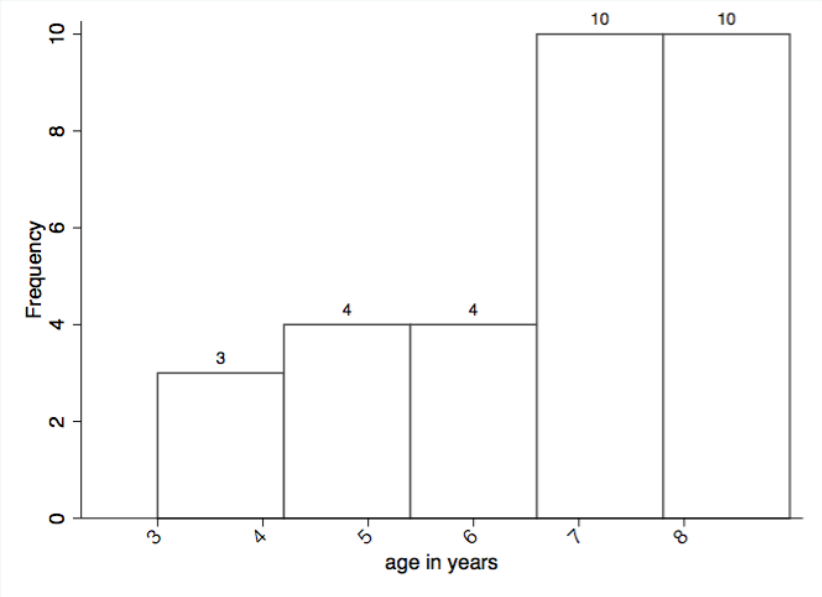


N=169



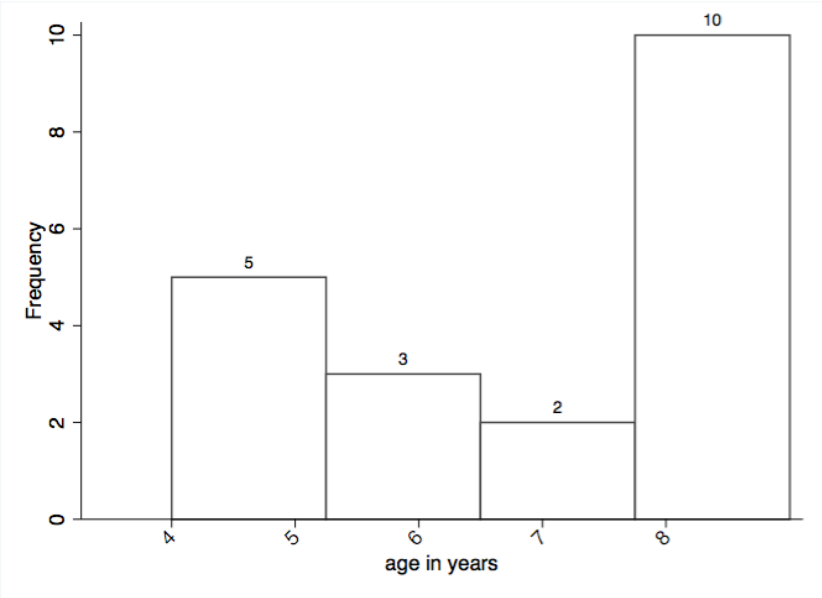
N=169

Figure 2.7. New ventures' failure age



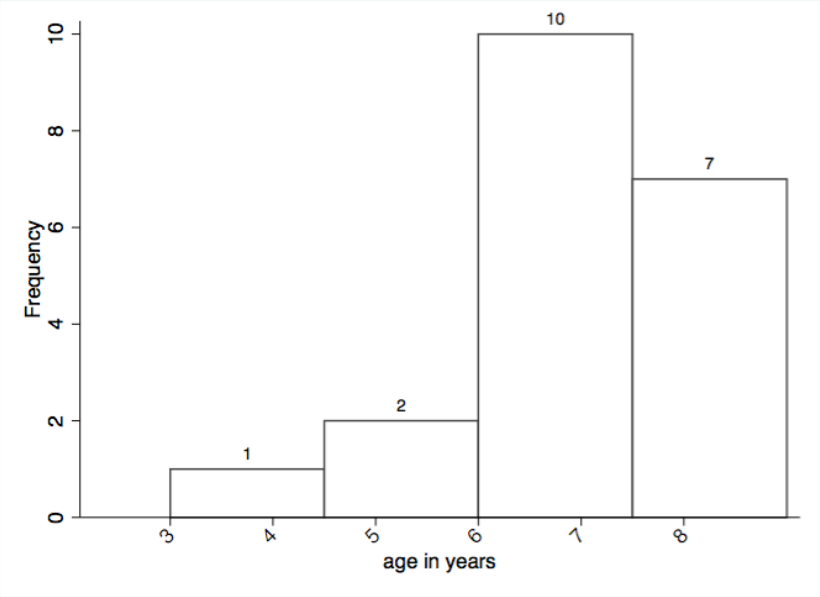
N=31

Figure 2.8. New ventures' age at the first VC fund acquisition



N=20

Figure 2.9. New ventures' age at the first business angels fund acquisition



N=20

2.3.2. Limitations of the dataset

Despite offering a rich and unique data on founders' career histories, the dataset used in this dissertation also suffers from a number of limitations. These limitations may have several implications for the findings presented in this doctoral thesis and therefore need to be addressed. Next to the missing data and sample representativeness (discussed in more detail in the following sections), the dataset suffers from a limited number of cases. In each of the two empirical studies, the complete information was available for only 148 firms. This limits our ability to detect interactions, as well as to add a large number of control variables.

Second, the dataset comprises a number of different sectors, each of which may have different implications with regard to the commercialization activities (e.g., different product development cycles, regulation). This may be a source of unobserved heterogeneity that we are unable to control for. Furthermore, it makes it difficult to compare performance. Due to the differences in cost-intensity and product development cycles, new ventures in some sectors may be faster than others to generate returns. Third, our dataset is an unbalanced panel data,

which suggest that the new ventures in our sample belong to different cohorts that may face different environmental constraints (i.e., subjected to different economic climates, changes in regulation etc). Each of these limitations are discussed in more detail at the end of each empirical chapter of this dissertation.

Missing data and subsamples

Although great efforts have been made to collect data from multiple sources, some data of interest could not be obtained, leading to the fact that our dataset suffers from missing data. This is particularly evident for variables including personal information about entrepreneurs and new ventures' board and investment characteristics. As a result, the two of our empirical studies are each performed on a separate subset of firms from our overall sample. The table below summarizes the number of observations in each of the subsamples, as well as the overlap between the two.

Table 2.7. Overview of the datasets used for the two studies

	N	Overlap study 1	Overlap study 2
Overall dataset	169	88%	88%
Dataset study 1 (Chapter 4)	148	100%	127 (86%)
Dataset study 2 (Chapter 5)	148	127 (86%)	100%

2.3.3. Sample representativeness

We used the population of technology-based new ventures identified by the IWT – Flemish governmental agency for Technology and Innovation. It needs to be noted that this is not a random sampling technique and new ventures may self-select into the dataset by actively applying for the governmental seed funds. Therefore, this sample may be not representative of the overall population of technology-based start-ups in Flanders, Europe or the world.

However, given that it is difficult and maybe even impossible to identify the full population of technology-based start-ups from which one could draw a representative sample, this dataset is well suited for the theory-testing we aim at, and offers a number of strengths in this regard. First, it includes a relatively large number of technology-based start-ups that consider themselves innovative and have certain levels of growth-orientation, as signaled by their application for the IWT grants. Second, the dataset spans across different sectors and technological domains, allowing us to examine environmental differences within the entrepreneurial process. Third, all new ventures are drawn from the same geographical region, suggesting that new ventures within the sample are subjected to the same national policies, and region-specific barriers to entrepreneurship. Fourth, consistent with prior studies, we find that the large share of new ventures in our sample are founded by teams, where group dynamics and synergies play a pertinent role in new venture development. In summary, our dataset is well suitable for theory testing. However, to test for its representativeness and the generalizability of our findings, replication studies on different datasets have to be performed.

2.4. Appendix to Chapter 2

Appendix 2.4.1. Construction of the initial IWT dataset

Before merging with the Research Foundation Flanders (FWO) in 2016, the Flemish Agency for Innovation by Science and Technology (IWT) supported innovation in Flanders, both within academia and industry. One of its programs provided grants of up to 50,000 Euros to technologically-advanced new ventures. Most of entrepreneurs starting this kind of ventures in Flanders apply for these grants, as they represent one of the most accessible ways of receiving seed capital. IWT actively encouraged entrepreneurs to apply for these funds and supported them with the application process.

Since 2009, IWT collaborated in constructing the database of technology-based start-ups in Flanders by providing yearly the contact information of all the applicants – including successful and not successful candidates. In 2009, the lists provided by the IWT included all new firms applying since 2006. IWT actively endorsed the participation in the data collection process, increasing the face validity and the likelihood of higher response rate. Based on the contact information provided by the IWT, the annual data collection was performed involving multiple data sources (secondary databases, web-search, interviews with the founders and surveys). Out of the total number of 258 identified and contacted firms, 169 (66%) participated by completing a questionnaire at several points of time. The overall information recorded on these firms resulted in an unbalanced panel dataset of 1,006 yearly observations.

Appendix 2.4.2. Measuring founding team composition

Consistent with prior research, the composition of the founding team is assessed by the means of two measures: (1) breadth of functional roles and (2) breadth of functional experience (Beckman & Burton, 2008; Bunderson & Sutcliffe, 2002). Breadth of roles describes the number of functional domains in which a team has formalized roles, while breadth of experience assesses the number of functional domains in which a team collectively has prior experience.

Founding team's breadth of functional roles is assessed by the means of a count measure assessing whether the firm has defined positions within the team that correspond to the following seven functional areas: (1) general management, (2) science/R&D/ICT/engineering, (3) sales and marketing, (4) manufacturing and operations, (5) finance/accounting, (6) strategic planning/business development, and (7) law and administration (including HR). These areas were identified by prior research as important functional domains for technology-based firms (e.g., Beckman & Burton, 2008; Boeker & Wiltbank, 2005). For each venture, it was recorded how many functional domains are covered by the positions within the founding team. For example, if a founding team consists of a CEO, Director of Discovery Research, Director of Marketing, and a Director of Business Development, this team has four established functions (general management, science/R&D/ICT/engineering, sales/ marketing, and strategic planning/business development) at the time of founding. Conversely, if the team consists of a CEO, Director of Discovery Research, Senior Director of Technology Development, and a Vice President in R&D, this team has two established functions (general management and science/R&D/ICT/engineering).

Founding team's breadth of functional experience, assesses whether the team has prior experience in the aforementioned seven functional areas. We code up to three prior positions

for every individual within these domains. For example, if one founder has worked as a CEO and as a technology developer, this founder has prior functional experience in two functional domains: general management and science/R&D/ICT/engineering. The second founder worked as a senior researcher, R&D specialist and technology developer, this person has functional experience in one domain: science/R&D/ICT/engineering. Collectively, these founders have prior experience in two domains, hence the team's breadth of functional experience is equal two.

Appendix 2.4.3. Comparing university spin-offs and independent technology start-ups

We performed a number of tests to see whether university spin-offs significantly differ from the rest of the firms in our sample. Table 2.8 provides some basic descriptive statistics with frequencies and corresponding percentages across two groups, university spin-offs and independent start-ups. About 41% of the academic spin-offs, compared to 58% of independent start-ups were founded to commercialize a product, approximately 29% (compared to 22%) commercialized services, and around 29% (compared to 19%) to do both. An equally large share of academic spin-offs and independent start-ups developed their products and services to market to other businesses, in a business-to-business model (ca 60% in both groups). Around 24% of spin-offs, compared to 34% independent start-ups targeted an end-consumer, while 12% of spin-offs (compared to 5% of independent start-ups) targeted both. There are some visible differences between the university spin-offs and other technology-based start-ups with regard to the industry sector. The largest share of new ventures operated within Business services (44% of academic spin-offs and 28% of independent start-ups). Only 12% of spin-offs (compared to 23% of independent start-ups) operated in ICT. With 29%, visibly more academic spin-offs (compared to 10% of independent start-ups) operated in Biotech and medical sectors. Fewer university spin-offs compared to the independent start-ups worked in industries related to Energy, electricity and electric devices, Construction and maintenance, and other sectors offering standard products for people's and animals' needs.

Table 2.8. Characteristics of university spin-offs and independent start-ups

Commercialization orientation	University Spin-off	Independent start-up	Total	%
Product	17 (41.4%)	75 (58.5%)	92	54.4
Service	12 (29.3%)	28 (22%)	40	23.7
Hybrid	12 (29.3%)	25 (19.5%)	37	21.9
Total	41	128	169	100

Business model	University Spin-off	Independent start-up	Total	%
Business-to-business	26 (63.5%)	77 (60%)	103	61
Business-to-consumer	10 (24.5%)	44 (34.5%)	54	32
Business-to-business-and-consumer	5 (12%)	7 (5.5%)	12	7
Total	41	128	169	100

Industry sector	University Spin-off	Independent start-up	Total	%
Business services	18 (44%)	36 (28%)	54	32
ICT	5 (12.5%)	29 (23%)	34	20.1
Biotech/ medical	12 (29.2%)	13 (10%)	25	14.8
Energy/ electricity/ electric devices	3 (7.3%)	18 (14%)	21	12.4
Construction/ maintenance	1 (2%)	10 (8%)	11	6.5
Other*	2 (5%)	14 (11%)	16	9.5
missing	0	8 (6%)	8	4.8
Total	41	128	169	100

Table 2.9 provides an overview of the two-group mean comparison tests. In line with the literature and prior empirical findings (e.g., Colombo & Piva, 2012; Mustar & Wright, 2010), university spin-offs within our sample have larger founding teams than their independent counterparts. Because larger teams tend to comprise a wider variety of functional roles, it is not surprising that university spin-offs within our sample have higher functional role diversity, although this difference is rather weak ($p < 0.1$). Also, consistent with prior research we find that the founding teams in university spin-offs tend to be more homogeneous with regard to founders' experience, as they are typically comprised of scientists and engineers with no, or little, commercial experience (Colombo & Piva, 2012; Ensley & Hmieleski, 2005).

Table 2.9. Team characteristics of university spin-offs and independent start-ups

	University Spin-off		Independent start-up		*P* two-tailed	*P* one-tailed[11]
	N	mean (SE)	N	mean (SE)		
FT size	41	2.29 (.16)	128	2.06 (.10)	.03	.02
FT role breadth	40	1.74 (.84)	121	1.60 (.75)	.12	.06
FT experience breadth	40	1.7(.89)	110	.19 (1.00)	.81	.60

[11] The difference between the mean of University spin-offs and the mean of Independent start-ups is above 0. [Ha = diff >0, diff= mean (University spin-off) – mean (independent start-up)]

CHAPTER 3: THE ROLE OF TEAMS IN ACADEMIC SPIN-OFFS

Abstract

Although teams play a crucial role in academic spin-offs, research on this topic is still in its early stage. In order to stimulate discussion and encourage further studies, this paper offers a much-needed overview of prior research on teams in the context of academic spin-offs. By examining studies from 1980 to 2016, our review shows that extant work has primarily focused on the human and social capital endowments of academic entrepreneurs, while much less attention has been paid to team formation and evolution, and team functioning. Based on a critical assessment of the status quo, we discuss open research questions and suggest that scholars need to account for the temporal context of academic spin-offs and for the type of technology that is commercialized. Furthermore, we encourage research on founder identities and the creation of social good via academic spin-offs, as such research would allow scholars to push significantly beyond the traditional view of academic spin-off teams that emphasizes personal wealth creation, licensing incomes and financial profit.

Key words: academic spin-offs, entrepreneurial teams, science commercialization, technology, review

3.1. Introduction

Academic spin-offs (ASOs) represent a small but economically important portion of high-tech ventures that are typically operated by teams (Bonardo, Paleari, & Vismara, 2010; Mustar & Wright, 2010). These teams often bring together individuals with technological and business competences in order to successfully commercialize novel and (potentially) disruptive technologies that emerge from academic research (Rasmussen, Mosey, & Wright, 2011).

In the present paper, we review extant research on the role of teams in the context of ASOs as ASOs have unique characteristics that differentiate them from other types of start-ups. Following prior research, we define an ASO as "a new company that is formed by a faculty, staff member, or doctoral student who left the university or research organization to found the company or start the company while still affiliated with the university, and/or a core technology (or idea) that is transferred from the parent organization" (Clarysse, Wright, & Van de Velde, 2011, p. 1421). The newly-founded ASO faces a unique set of challenges as it transitions from a scientific environment to a business context. In particular, spin-off teams have to cope with conditions of high market and technological uncertainty, as the commercialization process involves several phases—from research and opportunity screening to the proof of viability and maturity (Vanaelst et al., 2006). During the initial phases of the process, spin-off teams are mostly involved in the technical aspects of their ventures (e.g., prototype development and product development), while at later stages they need to choose a market application for their technology and develop a market (Shane, 2004).

While both ASOs and other new high-tech ventures experience difficulties in attaining a foothold in the marketplace, team formation and functioning may prove particularly challenging for ASOs (Colombo & Piva, 2012; Wright, Birley, & Mosey, 2004). Originating from a historically non-commercial environment that may be disapproving of those with an entrepreneurial orientation (Miozzo & DiVito, 2016; Vohora, Wright, & Lockett, 2004), academic entrepreneurs often lack commercial skills and prior professional experience in the private sector (Clarysse & Moray, 2004; Colombo & Piva, 2012; Mustar et al., 2006; Visintin & Pittino, 2014) and need to add external (surrogate) entrepreneurs to their teams in order to acquire business- and market-related competences (Lockett, Wright, & Franklin, 2003; Vohora et al., 2004). At the same time, academic entrepreneurs have a strong science identity that is often incompatible with an entrepreneurial mindset (Jain, George, & Maltarich, 2009). As a

result, they may experience conflict of interest as they are torn between their research and venture endeavors (Nelson, 2014) and may face tensions between remaining an academic or becoming an entrepreneur, or alternatively working part-time at both (Wright et al., 2004).

Against this backdrop, the purpose of our paper is to provide a systematic review of existing work on teams in ASOs and identify opportunities for further research. In effect, we reviewed studies at the intersection of teams and ASOs that have been published from the enactment of the Bayh-Dole Act in 1980 to 2016. We identified 43 pertinent studies that are presented in Table 3.1. In this paper, we analyze, map and discuss this body of work in order to make it readily accessible to researchers and outline a number of interesting paths for future research. Finally, we discuss in which ways the insights stemming from studies on ASO teams can contribute to the broader team literature.

Table 3.1. Summary table

Study	Sample	Key questions	Key findings
Bathelt, Kogler & Munro (2010)	18 spin-offs from the University of Waterloo, Canada	What are the typologies of academic spin-offs?	Most spin-offs with multiple founders were co-localized, regardless of the type of knowledge they utilized. Two thirds of spin-offs drew from generic knowledge.
Berry (1998)	New technology-based firms within science parks. Survey: 257 firms. In-depth interviews: 30 firms (both university spin-offs and independent start-ups), UK	Do managers of high-tech new ventures employ strategic planning? What role does a technical entrepreneur play?	Management teams with predominantly technical skills did not engage in strategic (long-range) planning. Management teams in which technical skills are balanced with those of other functional areas engaged in long-range planning exhibiting strategic orientation.
Bjornali, Knockaert & Erikson (2016)	103 academic spin-offs, Norway	What is the relationship between TMT characteristics and TMT effectiveness?	TMT effectiveness is positively affected by TMT diversity and cohesion. The relationship between TMT diversity and TMT effectiveness is mediated by board service involvement (BSI), while the relationship between BSI and TMT effectiveness is positively moderated by the higher proportions of board outsiders.
Bjornali & Gulbrandsen (2010)	11 academic spin-offs, Norway	Which board members do academic spin-offs add in the start-up stage? How do boards complement resources available to TMTs?	Founders' social capital serves as basis for board formation. At later stages (after legal incorporation), new board members bring in critical knowledge resources complementary to the TMT.

Bonardo, Paleari & Vismara (2011)	131 university spin-offs out of 499 high-tech SMEs that went public, Germany, UK, France, Italy	How is founders' university affiliation valued by external investors?	University spin-offs obtain higher initial market valuation, particularly when academics are present in the team. Yet, in the long run, they underperform their independent counterparts in terms of aftermarket valuation and operating performance.
Chen & Wang (2008)	112 technology-based new venture teams from the 65 research-based incubators (including university, governmental, and non-for-profit incubators), Taiwan	What are the effects of social networks and trust on a new venture's innovative capability?	Both internal and external social networks positively affect new venture's innovative capability, whereby trust within the team is an important moderator.
Ciuchta et al. (2016)	101 first generation university spin-offs and their subsequent progeny firms, USA	What experiences imprinted at the founding of a university spin-off influence subsequent spin-off activity?	The acquisition of formal equity at founding increases chances of a subsequent spin-off. The presence of a faculty founder in the ASO team negatively moderates this relationship, while prior start-up experience positively moderates this relationship.
Clarysse & Moray (2004)	Spin-off from the Universite´ Catholique de Louvain la Neuve (UCL), Belgium	How is a team of entrepreneurs formed in a high-tech start-up?	Managerial and business capabilities of a team evolve from the research phase to post-incorporation. Coaching of the founding team is considered as an alternative to hiring outside CEOs in the early formation stages.
Clarysse, Knockaert & Lockett (2007)	140 academic spin-offs, Belgium	Do the outside board members extend the human capital of founding teams? Is their human capital complementary or substitute to the team's?	University spin-off teams with strong R&D experience are more likely to attract outside board members that have complementary commercial and/or financial experience.
Colombo & Piva (2012)	196 founders of 64 academic and 181 founders of 64 twin non-academic technology-based new ventures, Italy	Do academic spin-offs exhibit peculiar characteristics, different from the non-academic start-ups?	Founding teams of academic spin-offs exhibit greater education levels and greater specialization in technical and scientific fields, while the degree of their industry-specific human capital, as well as managerial and entrepreneurial experience are comparably low.
Colombo & Piva (2008)	4 academic spin-offs, Italy	What are the strengths and weaknesses of academic spin-offs compared to other new technology-based ventures?	The shortage of commercial knowledge is a major weakness of academic spin-off teams. ASOs exhibit homophily, as founders team up with individuals with similar human capital and shared working experience.
Criaco et al. (2014)	262 Catalan university spin-offs, Spain	How do founders' specific human capital characteristics affect academic spin-off survival?	University human capital and psychic income from entrepreneurship are positively related to ASO survival, while industry human capital negatively affects ASO survival. Entrepreneurship human capital is (partially) positively related to ASO survival.

Czarnitzki, Rammer & Toole (2014)	20,241 knowledge-intensive start-ups, Germany	Do university spin-offs perform better than their industrial counterparts?	With a performance premium of 3.4%, university spin-offs perform better than industry start-ups. This performance premium is larger for research academic entrepreneurs.
De Cleyn, Braet & Klofsten (2014)	185 product-oriented academic spin-offs, 9 European countries	How do founding teams' and TMTs' experiences and their complementarity affect the survival of academic spin-offs?	Large team size and team heterogeneity of TMTs and boards are positively related to spin-off survival. Prior entrepreneurial experience in general and prior entrepreneurial experience in starting a high-tech venture are positively related to survival, whereas serial entrepreneurship seemed to have a negative effect. Characteristics of the founding team (incl. education, work experience, heterogeneity, participation, or prior entrepreneurial experience) showed no effect.
Ensley & Hmieleski (2005)	102 high-technology university-based start-ups & 154 independent high-technology new ventures, USA	What are the differences between tech-based university-spin-offs and independent tech-based new ventures in terms of TMT composition (education, functional expertise, industry experience, and skill), dynamics (shared strategic cognition, potency, cohesion, and conflict) and performance (net cash flow and revenue growth)?	Compared to independent start-ups, the TMTs of university spin-offs are more homogenous with less developed dynamics. University-spin-offs perform significantly worse in terms of net cash flow and revenue growth than independent new ventures. Team composition and team dynamics account for less variation in the performance of academic spin-offs than that of their independent counterparts.
Franklin, Wright & Lockett (2001)	57 universities' technology transfer offices, UK	Do successful universities (those with the largest number of spin-offs) prefer engaging researchers or surrogate entrepreneurs as a spin-off leader? What are the advantages and disadvantages of the two approaches?	Successful universities hold more positive attitudes towards surrogate entrepreneurs. The main advantage of an academic entrepreneur is her understanding of the technology, while the disadvantage is the lack of commercial expertise. The main advantages of a surrogate entrepreneur include her commercial experience, social network and motivation by financial gains, while the main disadvantages involve unreasonable equity requirements and diverging objectives to the academic inventors. The best approach may involve a combination of both academic and surrogate entrepreneurs.
Grandi & Grimaldi (2005)	42 academic start-ups, Italy	What organizational characteristics of academic start-up founding teams influence new venture success predictors (business idea articulation and market attractiveness of a business idea)?	Market orientation of the academic founders and their frequency of interaction with external agents positively affect market attractiveness of a business idea. The articulation of roles and prior joint working experience of the academic founders positively affect the depth of business idea articulation.
Grandi & Grimaldi (2003)	40 academic spin-offs, Italy	What predicts founding teams' intention to set up relations with external agents and the frequency of those relations?	The degree of founders' role articulation has a positive effect on the intention to set up relations with external agents, while the completeness of the founding team has a negative effect. The frequency of interaction with external agents at the time of founding is positively affected by their research groups' prior interactions with external agents and by teams' technological excellence.

Gurdon & Samsom (2010)	17 scientist-started ventures, USA & Canada	What happened to the scientist-started start-ups that were founded 12 year ago?	The majority of the scientists whose ventures survived believed that their success was due to the combination of science quality and business capabilities of their management team.
Heirman & Clarysse (2004)	99 research-based start-ups, Belgium	What are the different starting resource configurations among the research-based start-ups?	VC-backed start-ups tend to have larger founding teams, which they tend to extend with more professional managers during the 1st year. Prospectors tend to have large founding teams, but do not attract additional managers. Product start-ups are usually founded by small teams of 2. Transitional start- ups are usually founded by small teams (1 or 2 persons) of technical consultants without a concrete product idea.
Knockaert, Bjornali & Erikson (2015)	117 academic spinoffs, Norway	What are the effects of the role of TMT and board chair characteristics on board service involvement (BSI)?	TMT diversity positively affects BSI, while CEO duality has a negative effect. The industry experience of the board chair amplifies the relationship between TMT size and BSI, whereas CEO duality strengthens the relationship between TMT diversity and BSI.
Knockaert, Ucbasaran, Wright & Clarysse (2011)	9 academic spin-offs, Belgium	How can knowledge be transferred and used in science-based entrepreneurial firms in order to enhance their performance?	Tacit knowledge is most effectively transferred when a significant part of the original research team joins as venture founders. Commercial expertise and mind-set are also important, as long as the cognitive distance between scientists and the person responsible for commercialization is not too large.
Lockett, Wright & Franklin (2003)	75 university spin-offs, UK	In which areas can universities be more successful with regard to the development of spin-off companies?	The more successful universities have clearer strategies about the process of spinning out and the use of surrogate entrepreneurs.
Lundqvist (2014)	Quantitative: 170 ventures incorporated in 16 incubators; Case study: 1 high-performing incubator, Sweden	What is the impact of surrogate entrepreneurship on venture performance?	Academic ventures with surrogates outperform their counterparts.
Maine, Soh & Dos Santos (2015)	3 biotech firms (including academic spin-offs); 30 key decision in relation to the commercialization of biotech	When are scientist-entrepreneurs likely to exercise the principles of effectuation and causation as their ventures evolve?	Entrepreneurs select their founding partners using effectuation, through their personal networks.

	platforms, North America		
Miozzo & DiVito (2016)	18 British and 17 Dutch science-based firms (including academic spin-offs), UK and the Netherlands	How can science-based firms grow fast?	The development of resources that are critical for the growth of science-based firms, including a functionally-diverse management team, is an unfolding and interrelated process. The firms access managerial expertise via five paths (investor-appointed, founder-appointed, parent-appointed, founders-diversity, and founders-limited paths).
Mueller (2010)	1,810 academic spin-offs in research- and knowledge-intensive industries, Germany	What are the factors that cause time-lags in the establishment of academic spin-offs?	The time-lag is considerably shorter for spin-offs created by a team of founders. Combinations like natural science with engineering or business are more likely to found a spin-off soon after leaving public research.
Nicolaou & Birley (2003)	45 university spinouts comprising 111 inventors, UK	How do network non-redundancy and tie strength jointly influence academic exodus? Are there any systematic team-level structural differences between different spin-out structures?	The interaction between tie strength and network structure is important for resource acquisition via network ties. Academic teams of technology spin-outs are more likely to have less non-redundant ties in the team's business discussion network than orthodox and hybrid spinout teams.
Rasmussen, Mosey & Wright (2015)	3 academic spin-offs, 54 interviews with important players (e.g., company founders, entrepreneurial team members, researchers, university managers), UK and Norway	How do academic entrepreneurs form and further develop their social networks to build the entrepreneurial competencies needed for creating an independent spin-off venture?	All three competencies (opportunity refinement, resource acquisition, and championing) are developed concurrently for a new venture to succeed. Different competencies require different types of network ties of the founding team (weak vs. strong) but as the venture evolves other types play a critical role. Ties initially developed to access one competency could later be used to access another competency.
Rasmussen, Mosey & Wright (2011)	4 university spin-offs, UK and Norway	Which entrepreneurial competencies are needed for nascent spin-offs to reach the credibility threshold? Who provides these competencies? How are these competencies developed?	Three competencies (opportunity refinement, leveraging, and championing) were crucial for the ventures to gain credibility. The specific competencies for venture creation had to be developed internally through entrepreneurial experience or acquired from external actors.
Renault, de Mello, Fonseca & Yates (2016)	5 technology-based academic spin-offs, Brazil	How does the academic trajectory of the founding team influence the business model and performance of academic spin-offs?	Spin-offs inherit their initial resources from the academic environment—that in turn influences the adopted business model. The human resources involved in the creation of the new ventures were professors and students who were previously involved in academic research projects, with social capital predominantly from the academic environment.
Roberts (1990)	114 firms founded by former employees of the major laboratories and engineering departments of MIT, USA	How do the founding team members allocate their time in the early years of a high-tech new venture?	Team ventures devote a large proportion of their efforts to marketing and sales from the very beginning.

Rosa & Dawson (2006)	1st stage: 92 university spinouts 2nd stage: 8 female and 6 male survey respondents, UK	What is the participation rate of female academics in science commercialization? How do female academics behave as entrepreneurs?	Most of the female academics tend to be part of entrepreneurial teams that involve senior male colleagues.
Scholten, Omta, Kemp & Elfring (2015)	70 academic spin-offs, Netherlands	To what extent does human capital leverage the effect of bridging ties on the early-stage growth of academic spin-offs?	Bridging ties increase early-stage employment growth. This relationship is amplified by prior domain-specific and prior start-up experience.
Shane & Stuart (2002)	134 MIT spin-offs, USA	How do initial resource endowments affect organizational survival and IPO?	New ventures with founders, who sustain direct and indirect relationships with venture investors, are more likely to receive venture funding. The industry experience of the team has a positive effect on the hazard of IPO.
Vanacker, Manigart & Meuleman (2014)	9 bio-tech start-ups (including academic spin-offs), Belgium	How do scientific entrepreneurs influence the formation of early ties with VC investors? How do these early investment tie decisions influence the formation of subsequent ties?	The formation of early investment ties is path-dependent, as entrepreneurs tend to approach only one or a few prospective investors from their institutional context. Differences in experience among early investors influence the professionalization of entrepreneurial teams. This, in turn, influences the extent to which subsequent investment tie formation is path dependent or more amenable to intentional management.
Vanaelst, Clarysse, Wright, Lockett, Moray & S'Jegers (2006)	10 academic spin-out projects, Belgium	What are the dynamics of entrepreneurial teams across the different stages of the spin-out process?	Teams evolve and change in composition over the different stages of the spin-out process. New team members bring in different kinds of experience, but they do not alter the perspective of doing business.
Visintin & Pittino (2014)	103 university-based spin-offs, Italy	How do the demographic variables of entrepreneurial teams create a balance between the scientific and business orientations? What is their impact on performance?	Founding teams that concurrently promote differentiation and integration of academic and non-academic profiles are performing better.
Vohora, Wright & Lockett (2004)	9 university spin-offs from seven universities, UK	What phases do the university spin-offs go through in their development?	The locus of entrepreneurship moves from the initial entrepreneur to the team, as the venture evolves. Along this process, the team needs to develop different types of competences, in order to overcome the critical junctures it faces.
Walter, Schmidt & Walter (2016)	158 spin-offs from public universities and research organizations, Germany	What is the relative influence of founding team characteristics (expert knowledge and entrepreneurial orientation), compared to the influence of organizational characteristics on academic entrepreneur's propensity to seek patents?	Founding team characteristics matter in weak, but not strong regimes. The opposite holds for organizational patenting norms.

Wennberg, Wiklund & Wright (2011)	Longitudinal set of corporate spin-offs and university spin-offs, Sweden	What is the relative effectiveness of university spin-offs vs. corporate spin-offs?	Corporate spin-offs have more substantial human capital endowments. However, some endowments (such as industry experience) matter more for university spin-offs.
Woiceshyn (1993)	5 medical biotechnology firms (including academic spin-offs), Canada	What differentiates the more effective from the less effective firms?	The four more effective firms have different management teams than the less effective one. All four were founded by inventor-entrepreneurs (university professors) who sought to commercialize their own inventions. They all remained managers in their firms, had more complete management teams, and applied the innovative (as opposed to prestige) logic.
Wright, Lockett, Clarysse & Binks (2006)	UK: 124 surveys from TTOS, interviews with 11 TTOs, 27 surveys from VCs; Supplemental data from Continental Europe	What are the problems that university spin-out companies (USOs) experience when seeking to access venture capital?	In contrast to non-USOs, investors of USOs do not put much emphasis on a working prototype and the availability of a professional management in place before the investment is made. However, investors consider that the development of a management team in USOs involve a greater risk that non-USOs. Compared to the venture-backed USOs, USOs involving joint ventures with corporations have resource benefits from the prior knowledge of their industries and are better positioned to develop viable opportunities from scientific discoveries.

3.2. Literature review: ASO teams

In order to make existing knowledge available to researchers and to establish a platform from which interesting avenues for future research can become visible, the following sections present the key research insights from the reviewed set of studies on ASO teams. Following categorizations applied in the team literature (Klotz, Hmieleski, Bradley, & Busenitz, 2013; Kozlowski & Bell, 2013; Mathieu, Maynard, Rapp, & Gilson, 2008), we have grouped existing work into studies that seek to understand the role of ASO teams by examining team attributes, team formation, and team functioning. The vast majority of the reviewed studies focus on team attributes by looking at the human and social capital endowments of academic and non-academic team members. Because of their conceptual distinctiveness—with the former focusing on the resources internal to the firm and the latter on the resources externally acquired—we separate team attributes into two streams, one for the human capital endowments and another one for the social capital endowments. A third, smaller stream of research explores

team formation and evolution by acknowledging the dynamic nature of ASOs over time. Finally, we identify a fourth stream that appears to be in its infancy in the context of ASOs and explores team functioning.

3.2.1. The human capital of ASO teams

There are several human capital team attributes that have garnered most of the attention in ASO research. Below, we will discuss team size, the human capital endowments that are unique to ASOs, as well as other human capital characteristics that differentiate ASOs from other types of ventures.

ASO team size. Science commercialization via the creation of a spin-off company requires a variety of capabilities that a single person usually does not possess. Hence, the majority of ASO ventures is created and managed by teams rather than by single individuals (Visintin & Pittino, 2014). With an average number of 2.3 versus 1.6 members, ASO teams tend to be somewhat larger than the teams of independent start-ups (Czarnitzki, Rammer, & Toole, 2014; Ensley & Hmieleski, 2005). Despite the importance of team size, which is the most general characteristic of any team, findings remain inconclusive, as both positive and negative effects have been ascribed to larger ASO teams.

On the one hand, large teams signal quality and are therefore more interesting to investors (Clarysse & Moray, 2004). Furthermore, research has found that spin-offs created by large teams tend to achieve higher growth (Czarnitzki et al., 2014) as they are more likely to possess the capabilities required to successfully bring new technology to the market. On the other hand, however, larger teams can experience a number of challenges due to coordination problems and overhead costs (Clarysse & Moray, 2004; Visintin & Pittino, 2014). Also, larger teams may experience lower incentives to monitor one another, resulting in lower reciprocity

and a higher likelihood of free-riding behavior (Visintin & Pittino, 2014). Along these lines, other studies argue that smaller teams are not necessarily at a disadvantage, as they can compensate their own shortcomings by making use of external knowledge resources (Knockaert, Bjornali, & Erikson, 2015).

Human capital unique to ASOs. The academic profile of entrepreneurs. An important part of the reviewed studies draws attention to the idiosyncratic human capital of ASO teams—i.e., the academic profile of the spin-off entrepreneurs (Bonardo, Paleari, & Visamara, 2011; Czarnitzki et al., 2014; Knockaert, Ucbasaran, Wright, & Clarysse, 2011; Lundqvist, 2014; Müller, 2010; Visintin & Pittino, 2014). The proportion of academics in the founding team seems to be an important indicator of the spin-off performance. A high proportion of the original research team joining the venture can facilitate the transfer of tacit knowledge that will, in turn, increase the chances of reaching sufficient post-founding speed to first product (Knockaert et al., 2011). Yet, by including non-academics, who bring along business knowledge, teams are able to integrate science with the demands posed by customers and the broader business world, leading to a positive effect on spin-off performance (Visintin & Pittino, 2013; Lundqvist, 2014).

While the best composition of academics and non-academics in a spin-off venture depends on various features, there seem to be several factors that facilitate, or hinder, the integration of science and business knowledge. Knowledge integration can better be achieved when the cognitive distance of the team's members is not too large (Knockaert et al., 2011). Accordingly, prior common affiliation in the same research group or a common background of academics and non-academics in the team can increase trust and facilitate knowledge integration. On the contrary, a large team size will hinder knowledge integration, because internal communication, monitoring and team members' motivation to participate in team

efforts is more problematic. Diversity in members' academic status will also mitigate the benefits derived from team profile differentiation, as this type of diversity tends to lead to sub-groups with different norms and status disparity (Visintin & Pittino, 2014).

Surrogate entrepreneurs. Along with their technological competencies, ASOs will also need to possess market-related capabilities in order to successfully commercialize their invention. Yet, originating from the academic environment, founders of these ventures often lack the professional networks and the necessary commercial expertise, which in turn makes them less attractive to external investors (Clarysse & Moray, 2004). To counteract this deficiency and help new ventures transcend the so-called "Valley of Death", ASOs may add surrogate entrepreneurs to their teams—i.e., entrepreneurs from outside the academic institution (Lockett et al., 2003; Vohora et al., 2004). Whereas research indicates that ASOs engaging with a surrogate entrepreneur perform better than those that do not (Lundqvist, 2014), identifying and acquiring a surrogate entrepreneur can prove to be difficult for ASOs due to several reasons, such as the limited social capital of academic entrepreneurs and their reluctance to give up control. Moreover, academic institutions are not always in the position to indicate suitable persons to undertake this role (Franklin, Wright, & Lockett, 2001; Vohora et al., 2004).

Entrepreneurial human capital. ASOs are systematically different in their human capital endowments when compared to their corporate counterparts or to independent start-ups. For example, they score rather low on industry and entrepreneurial experience, while they exhibit superior education, technical and scientific specialization (Colombo & Piva, 2012). ASOs also tend to be more homogeneous than independent high-tech ventures in terms of education, industry experience, and entrepreneurial experience. This is because they often recruit their top

management team (TMT) from the university community and imitate the TMT composition of other university-based firms (Ensley & Hmieleski, 2005).

In addition to these differences in team composition, the performance effects of human capital characteristics are different in the context of ASOs compared to non-academic ventures. For instance, prior research has shown that entrepreneurial experience is more beneficial for corporate spin-offs, while industry experience plays a more important role in ASOs (Wennberg, Wiklund, & Wright, 2011). These findings suggest that it is worthwhile understanding the different configurations of human capital endowments that arise in the unique context of ASOs, as well as performance differences to other types of new ventures.

Founders' prior entrepreneurial experience is the human capital characteristic that has attracted much of the scholarly attention in the context of ASO teams. Understanding the effects of prior entrepreneurial experience is important because such experience endows entrepreneurs with valuable insights into the common challenges associated with new firm creation (Gruber, MacMillan, & Thompson, 2008). Founders or TMT managers with prior start-up experience benefit from their experience in identifying market opportunities for their technologies, in building a customer base, in obtaining external advice, in acquiring funding, and in other important activities. Yet, findings are inconclusive regarding the role of prior start-up experience in ASOs. For instance, Rasmussen, Mosey and Wright (2011) find that the start-up experience of the founding team can contribute to the development of firm competences that are crucial for establishing credibility in the new firm setting. However, other studies have failed to find a positive effect on ASO survival and performance (Shane & Stuart, 2002; Scholten, Omta, Kemp, & Elfring, 2015). This discrepancy may be attributed to the fact that the type of entrepreneurial experience is not typically accounted for. For instance, De Cleyn and colleagues (2015) showed that the entrepreneurial experience of ASO management teams

increases the survival odds of the venture, but not in the case of serial entrepreneurs who may be susceptible to overconfidence bias and entrepreneurial euphoria.

Another key human capital endowment that has attracted scholarly attention, albeit limited, in the context of ASOs is industry experience. ASOs tend to start without people possessing industry experience. As technologies can be commercialized in different settings, industry experience has an intriguing role within ASOs as it may draw founders to some settings and not others. More generally, research has shown that industry experience is important for the survival and success of new ventures, as entrepreneurs with industry-specific experience engage in less "trial and error" learning than entrepreneurs without such experience (Dencker & Gruber, 2015). While there are studies reporting the expected positive association of industry experience with firm performance, such as the hazard of IPO (Shane & Stuart, 2002), there are also counter-intuitive findings suggesting that industry experience may decrease ASO survival rate. This is because industry experience may increase the opportunity costs of the entrepreneurial activity vis-à-vis other occupations and in turn, affects the entrepreneur's threshold of performance (Criaco, Minola, Migliorini, & Serarols-Tarrés, 2014).

Team diversity. Only few studies in our sample examine diversity in team characteristics—beyond the already discussed notion that individuals with an academic background will likely have to add additional competences to their spin-off team. This could be partly explained by the fact that ASOs tend to be more homogeneous than independent start-ups (Ensley & Hmieleski, 2005). Yet, ASO teams can still possess different degrees of diversity that would affect their functioning. For example, Knockaert, Bjornali, and Erikson (2015) illustrate that team diversity, as a composite of diversity in several elements (i.e., functional background, education, industry background, founding experience, executive experience, and

international experience), can spur dysfunctional conflict and induce difficulties in decision-making.

Furthermore, team diversity has been examined in terms of their members' cognitive distance. In this vein, Knockaert and colleagues (2011) show that having both technological and commercial mindsets in a team is important, as long as the cognitive distance between scientists and the person responsible for commercialization is not too large. Large cognitive dissimilarity between technical and non-technical team members can prove detrimental to team functioning, as it hinders communication and impairs effective knowledge sharing that is needed to successfully commercialize a technology.

3.2.2. The social capital of ASO teams

The team's social capital is considered to play an important role in ASOs (Bathelt, Kogler & Munro, 2010; Grandi & Grimaldi, 2005; Grandi & Grimaldi, 2003; Shane & Stuart, 2002; Nicolaou & Birley, 2003; Rasmussen et al., 2011; Rasmussen, Mosey, & Wright, 2015; Renault et al., 2016; Vanacker, Manigart, & Meuleman, 2014). Like other entrepreneurial ventures, ASOs are resource-constrained entities that have to obtain external knowledge and other forms of support in order to become viable organizations. However, given the specificities of the environment in which these ventures are born—the academic context—spin-off teams have strong needs to augment their skill set and to attract other kinds of resources. Hence, the social ties that the founding teams of ASOs have assembled during their careers and that they will create during the launch process are vital to their ventures' positive development. While there is a relatively small number of studies that address this issue, there is evidence suggesting that the social capital of ASO teams demonstrates certain particularities. For example, research along these lines shows the limitations that the ASO team characteristics entail in relation to the external context. Research indicates that ASO teams are formed by

members that are co-localized (Bathelt et al., 2010) and that they rely on their interaction with actors coming from the academic environment (Renault et al., 2016) or actors that are somehow related to research—such as research institutions, institutions for technological transfer of research results, and public institutions—in order to develop a product that will be attractive to potential customers (Grandi & Grimaldi, 2005). In a similar vein, the search behaviour of founders in ASOs appears to constrain the pool of investors. As they tend to look for investors within their founding context, they lack information about potential options, and they are reluctant to disclose private information (Vanacker et al., 2014). This early choice of investors is critical for the newly-founded firms as it influences subsequent tie formation. Specifically, initial tie formation with inexperienced investors is path-dependent, as they are not in the position to satisfactorily professionalize the entrepreneurial team. That is not to say that the initial ties of academic entrepreneurs remain unaltered over time. On the contrary, as the venture evolves, the team may iteratively transform the strength and purpose of their relationships depending on the type of the competency they seek to develop and the stage of business development they go through (Rasmussen et al., 2015).

Several studies look at features of social networks that are commonly studied in network research and they find that direct, indirect, and bridging ties of the spin-off team (or the lack of such ties) are determinants of firm failure, VC funding, and employment. Prior direct and indirect ties with financial investors have been found to decrease the likelihood of failure and increase the likelihood to receive external funding (Shane & Stuart, 2002). Accordingly, a large number of bridging ties in the spin-off's external network can increase early employment growth, as they provide access to non-redundant and diverse information that will allow them to identify multiple business opportunities and pursue the most promising one (Scholten et al., 2015).

Finally, Nicolaou and Birley (2003) provide an interesting twist by showing that different types of ASOs exhibit systematic differences in their levels of external network non-redundancy. Specifically, they find that teams in what they call "orthodox" ventures (i.e., spin-offs that are created when the academic inventors spin out from the academic institution) and "hybrid" ventures (i.e., ventures that occur when academics retain their university position, but still have a substantive connection with the newly created firm) are more likely to sustain non-redundant contacts than teams founding "technology" ventures (i.e., ventures that occur when the technology spins out from the institution).

3.2.3. Team formation and evolution

While most of the reviewed studies have pointed to the team attributes that are needed for ASOs to succeed, it is important to identify where these competences come from, who provides them and how they evolve over time. In this regard, a smaller stream of research has focused on team formation and evolution and reveals that ASO teams are far from being static, and should therefore not be viewed as immutable entities (Clarysse & Moray, 2004; Vanaelst et al., 2006; Rasmussen et al., 2011). As academic ventures progress through the different phases of the spinning out process they face a set of critical junctures, the completion of which requires the continuous development of competences (Vohora et al., 2004). Consequently, their teams need to evolve and change in composition (Vanaelst et al., 2006).

By adopting a process lens, a small number of studies have examined spin-off development in closer detail, delineating how the activities and the capability requirements of the team change along the different phases of academic venture development (Clarysse & Moray, 2004; Rasmussen et al., 2011, 2015; Vanaelst et al., 2006; Vohora et al., 2004). While these studies use different labels to identify distinct phases of the ASO process and more studies are needed for common themes to emerge, there are some initial insights with regards to the

development of the ASO team. For instance, research agrees that spinning-out an academic venture is a very long process, with the legal founding usually postponed until all necessary elements, including a team's managerial and commercial capabilities, are in place. Consequently, scholars find that the pre-founding stage, including idea generation, opportunity framing, and pre-organization, takes long—sometimes as long as 15 years from research idea to formal incorporation (Rasmussen et al., 2011)—and usually consists of several phases through which the team needs to develop and recombine its capabilities (Clarysse & Moray, 2004; Vanaelst et al., 2006; Volhora et al., 2004; Rasmussen et al., 2011).

A number of studies have indicated that the early team tends to be highly homogeneous, as it usually originates from the university research group (Clarysse & Moray, 2004; Vanaelst et al., 2006) and as such, its formation is strongly influenced by founders' personal network ties, as opposed to external recruitments (Maine, Soh, Santos, 2015; Miozzo & DiVito, 2016). In the early pre-founding stage, the research team tends to develop a "champion" role – a researcher who assumes initial leadership, by driving the idea forward, and whose main tasks include writing a business plan and assembling the team based on the required competences at this stage (Clarysse & Moray, 2004). While some initial founders drop out at this early phase, as they wish to maintain their career in academia (Vanaelst et al., 2006), other members may be added to the team using the networks of founders, universities, and potential investors.

Surrogate entrepreneurs may also have to be added to develop managerial and commercial capabilities of the team (Vanaelst et al., 2006; Locket, Wright & Franklin, 2003), as well as to signal credibility to potential investors (Vohora et al., 2004). Yet, research is not conclusive about the best time to add an external member with complementary expertise. On the one hand, a team in the early opportunity identification phase would benefit from a surrogate entrepreneur, who would bring along her industry knowledge, entrepreneurial experience and social capital, in order to help the ASO in identifying a market gap that is

promising for its technological discovery (Rasmussen et al., 2011; Vohora et al., 2004). On the other hand, the team may first need to go through a process of learning before it hires externals, as academics are often unwilling to give up ownership and managerial power, and thus tend to oppose the hiring of outsider-CEOs. Until then, the team can acquire the necessary commercial knowledge via external advice (Rasmussen et al., 2011) and coaching (Clarysse & Moray, 2004). Involving a surrogate entrepreneur would then become critical at a later stage, when the spin-off needs to gain credibility and raise seed funds to establish the venture (Vohora et al., 2004).

Subsequent hires and restructuring of the team beyond the time of the venture's legal formation are important activities that help the venture in keeping up with changing organizational demands (Clarysse & Moray, 2004) and in developing entrepreneurial capabilities to overcome deficiencies stemming from decisions made during previous development phases (Vohora et al., 2004). As the spin-off grows, it can acquire managerial expertise via several paths, such as the networks of their investors or by making appointments from the universities they originate from (Miozzo & DiVito, 2016). Next to adding new team members, spin-off teams also experience member exits. While entries, as previously discussed, are mostly motivated by the need to acquire additional human, technological, or financial resources, and the entrepreneurs' ambition to reach the next step in a firm's life cycle, team exits tend to be related to team conflict (Vanaelst et al., 2006). Hence, the evolution of an ASO team is likely to depend both on the changing task requirements, as well as the overall functioning of the team.

3.2.4. Team functioning

Team evolution and the effects of team attributes on ASO performance are not independent from team functioning and the underlying team mechanisms. However, less than a handful of

the reviewed studies have explicitly looked into these issues, by focusing on prominent concepts within the broader team literature such as trust and team cohesion. For example, trust has been found to facilitate information exchange within the team, but also to inhibit inflows of external information, as teams with high levels of trust tend to value more internally generated ideas than ideas coming from outsiders (Chen & Wang, 2008). Accordingly, the cohesion of academic entrepreneurial teams seems to be positively related to team effectiveness (Bjornali, Knockaert & Erikson, 2016) and the financial performance of ASOs (Ensley & Hmieleski, 2005). These initial insights reveal that opening the "black box" of the role of team functioning is critical to improve our understanding of teams in ASOs.

3.3. Promising avenues for future research

To capture the role of teams in ASOs, extant research has heavily focused on the human and social capital attributes of the team, mainly adopting a cross-sectional approach, and has only touched upon issues of team evolution over time or team functioning. These research streams have accumulated a number of interesting findings, yet a vast number of intriguing, open research questions wait to be explored. In the following, we propose a number of future research avenues to scholars who seek to move the discussion forward.

First, we propose that future studies could look more deeply at the composition of team attributes, in terms of the team's human and social capital. While team attributes in ASOs have attracted most of the scholarly attention to-date, we still possess an insufficient understanding of several aspects of team composition—such as the diversity of attributes in a team and the effect that varying degrees of these attributes have on ASO performance. Second, scholars could explore the antecedents of the founding team at the start-up phase within the group of ASOs. Extant studies have shown which factors differentiate ASOs from non-academic ventures, but more needs to be done with regard to drivers of any systematic differences across

ASOs. Third, our literature review points out that very few studies have focused on team functioning and the mechanisms through which ASO team attributes affect performance. We argue that more needs to be done in this regard as well so that the "black-box" (Lawrence, 1997) connecting team attributes with organizational outcomes can be opened up. Fourth, we argue that research could produce richer insights, if it explicitly accounted for the temporal context of ASOs (Wright, 2014). Spinning out an academic venture is a dynamic process that requires time and a continuous reconfiguration of teams' competences as the venture moves along different phases of development (Vanaelst et al., 2006; Vohora et al., 2004). Consequently, the effects of team attributes would not remain unaltered as the spin-off moves from product development to market launch. Yet, apart from a few studies focusing on team evolution, the temporal context tends to be neglected. Fifth, we expect that the composition, evolution and functioning of a team will be contingent on the technology that is commercialized. Despite the core role of technology in ASOs, there is a surprising lack of research that examines whether and how the effects of team characteristics are contingent upon the technology itself. This is astounding, given that ASOs are typically "formed around a technology" (Knockaert et al., 2011, p. 778). Finally, we make several methodological propositions that would set the ground for future research at the intersection of teams and ASOs. Table 3.2 summarizes our ideas for future research.

Table 3.2. Research themes and open research questions

		Contingent Effects	
Research themes	Open Research Questions	Temporal context	Technology
Team composition	How could team attributes (e.g., industry, start-up experience) be best distributed within the team? Should a single person or a certain proportion of team members possess a particular type of experience? How do certain combinations of experience affect performance? When do certain combinations of team characteristics result in faultlines? What benefits spin-off success the most: in-depth industry-specific experience in a single industry or industry breadth? Which type of prior entrepreneurial experience in a team is more beneficial for ASO performance? Are there any differences if it is possessed by (1) an academic with no prior strategic-making experience, (2) surrogate entrepreneur, or (3) another academic inventor who has acted as a CEO in a previous start-up? What type of team functional diversity is more beneficial for ASO performance: teams that are composed of specialists or generalists? How does the composition of the ASO team affect the type of its network contacts? What are the (social and role) identity configurations that can occur in ASO teams? What are the effects of pure vs. hybrid identities on performance? When do ASO teams decide to	What are the effects of team attributes across the different stages of spin-off development? What are the performance effects of industry-specific experience across the different stages of spin-off development? When is industry breadth or depth more beneficial? At what stage of spin-off development are teams composed of specialists more beneficial than teams composed of generalists and vice versa? When do ASO teams create and sustain relationships with external actors that possess supplementary knowledge and skills, as compared to complementary knowledge and skills? What are the effects of different configurations of identity in an ASO team across the different stages of spin-off development?	Do the benefits of certain team attributes and the diversity thereof depend on technology characteristics, such as the scope of the technology commercialized? Are academic spin-offs commercializing technologies with high levels of technology scope better off by forming diverse teams, composed by scientists and individuals with industry, entrepreneurial and other business-related experience?

	pursue social goals with their spin-off creation activities? How prevalent are founders with Communitarian or Missionary identities in university settings relative to founders with a Darwinian identity (cf. Fauchart & Gruber, 2011)?		
Team formation & evolution	What are the antecedents of founding team characteristics? How do individual characteristics of the original inventor (e.g., human and social capital, identity, personality) affect the composition of the founding team? How do originating institutions affect team formation? How does the focal research domain affect team formation?	How do teams evolve over time beyond legal founding? How do member entries and exits create or alter faultlines? When would it be the best timing for acquiring a surrogate entrepreneur?	What are the implications of technology scope for team evolution? How does the initial team member profile shape the scope of a technology that is to be commercialized? How does the scope of the technology commercialized affect the suitability and selection of team members?
Team functioning	What are the mechanisms through which team attributes affect performance? How does knowledge-sharing occur in teams whose members represent separate subgroups holding distinct pieces of knowledge (e.g., academics vs. surrogates)? How do faultlines affect communication within such teams? How do different team configurations (e.g., academics holding different academic status, members endorsing different identities, or academics vs. non-academics) engage in discussions to successfully promote task conflict, while keeping affective conflict low? Is there an "average" team configuration that would lead to an "ideal" balance of conflict and effective contestation of ideas?	How does team functioning and its effects on performance change over time? How do team member exits and new member additions influence knowledge sharing and conflict? What are the challenges in team functioning when new entrants are perceived as similar others compared to dissimilar others? Does the "ideal" balance of conflict depend on the phase of ASO process? When do teams benefit from task conflict and when from cohesion the most?	Are there any systematic differences in the level of conflict ASO teams experience for different degrees of technology scope? How does conflict mediate the relationship between team composition and firm performance, when comparing ASOs that exploit low vs. high scope technologies?

3.3.1. Composition of team attributes

Distribution of team human and social capital attributes. The vast majority of the reviewed studies have looked at a number of team attributes. Yet, we still lack understanding of how these attributes could best be distributed within the team. The demography approach (Pfeffer, 1983) offers an influential lens through which scholars can more clearly approach this question, because an essential feature of this approach is that it does not limit its attention to the mere presence or the "average value" of a team characteristic, but it extends its focus to the distribution of endowments within the team (Beckman, Burton, O'Reilly, 2007). For example, this lens could be applied to examine how industry experience should best be distributed within a team: should a single person or a certain proportion of team members possess this experience for a team to succeed? This could have implications for the selection and the role of surrogate entrepreneurs in ASOs. Would industry experience of this one person suffice, or would the venture need more team members with industry experience? Taking it a step further, under what conditions, would the academic venture maximize the benefits? If a second surrogate entrepreneur enters the team or else an academic, who possesses industry experience along with her technological expertise? Put differently, it would be interesting to understand whether the industry experience of team members coming from the business domain is of the same value as industry experience that academics may happen to have.

Accounting for team diversity can enrich our knowledge of spin-off team composition, but it also involves the risk that some forms of team heterogeneity or the presence of subgroups go unnoticed. Identifying group faultlines in a team can mitigate this risk, as faultlines can be strong at low levels of diversity—that would mistakenly lead to the impression that a team is homogeneous (Lau & Murnighan, 1998). Departing from demographic diversity constructs that typically address one team characteristic at a time, faultlines are "hypothetical dividing lines that may split a group into subgroups" based on one or even more importantly on a combination of different team member characteristics, such as demographics, personality, and

values (Lau & Murnighan, 2005; 1998, p. 328). This would be particularly important in the context of ASOs, as the profile of teams in this context is fairly complex. The mix of academics with surrogate entrepreneurs, different combinations of prior work experience, as well as the different status level of academic members (i.e., senior vs. junior academics) can lead to different degrees of faultlines in a team that would subsequently impact its functioning and performance.

Deeper understanding of team attributes. The reviewed studies have examined the effect of team human and social capital endowments (such as industry experience, entrepreneurial experience, functional diversity, and network ties) on performance, but they often yield inconclusive findings. We therefore see merit in delving deeper into these key team characteristics.

For instance, given that most extant research has examined industry experience in terms of the degree to which the team or a team member possesses experience in the target industry, it is not yet clear what benefits science commercialization the most: in-depth industry-specific experience in a single industry or industry breadth, i.e., diversity of industry experience. The answer to this dilemma would have important implications for team composition, as spin-offs could look for the addition of surrogate entrepreneurs, who possess the right mix of industry depth and/or breadth. On the one hand, in-depth knowledge of an industry provides teams with key insights that allow for adequate assessment of threats and opportunities within this particular setting. On the other hand, when ASOs seek to identify a market for their technology and tackle market uncertainty (Shane, 2004), industry-specific experience may constrain a team's choice of the market to enter (Gruber, MacMillan, & Thompson, 2013). As individuals generally prefer options that they can rely on based on their prior experience, the market entry choice may be based on team's familiarity with a particular industry rather than on the best

alternative. As a result, they may settle for a "local optimum" rather than the most promising market.

Accordingly, a promising line of research could be to disentangle which type of prior entrepreneurial experience matters the most. Because not every single member of a new venture team is equally committed to the venture or involved in its strategic decisions, only entrepreneurial experience that entails strategic-decision making experience may be beneficial in science commercialization. For instance, would prior entrepreneurial experience of an academic inventor, who did not have an active role in the strategic-making of her previous start-up, qualify in the same manner as the prior experience of a surrogate entrepreneur or another academic inventor who has acted as a CEO in a previous start-up?

Similarly, when examining the effects of functional diversity of the ASO team, future research could look more closely into the breadth of team members' prior functional experience. This would enable researchers to distinguish between teams that are composed of specialists vs. generalists and help to answer the important question of what type of diversity benefits ASO teams the most: teams that are composed of specialists in different functions (i.e., academic researchers with no other functional experience and business managers with no technical background) or teams composed of generalists (i.e., academic entrepreneurs with functional experience in other domains). Specialists possess unique in-depth understanding of their field, yet they may be unable to fully exploit their knowledge, as cross-functional communication and coordination may prove problematic. On the contrary, generalists may not possess as much in-depth knowledge, yet they do not face the same communication barriers and may therefore be better able to capitalize on their diverse functional experience (Bunderson & Sutliffe, 2002).

Finally, it is also worth examining how the composition of the team influences the type of external network contacts they seek to sustain—contacts that possess supplementary, as compared to complementary knowledge and skills. For instance, scholars could examine

whether a team that is primarily composed by scientists seeks for complementary knowledge from business contacts or whether they exhibit similarity bias and network with like-minded individuals.

Team characteristics beyond team human and social capital. Scholars can also enhance understanding of the role of teams in ASOs, by looking at team characteristics beyond the team's human and social capital endowments. In particular, we propose that future research looks at the composition of identities that ASO team members hold. Understanding identity is key, as the entrepreneur's identity has a profound effect on new firm creation (Fauchart & Gruber, 2011; Gruber & MacMillan, 2017; Powell & Baker, 2017). This would be especially intriguing in the context of ASOs, as academic scientists come from a traditionally non-commercial environment (Miozzo & DiVito, 2016; Vohora et al., 2004) and experience difficulties in balancing the different norms of science and business worlds (Jain et al., 2009; Gurdon & Samsom, 2010). At the same time, non-academics with a strong business background may be added to the team bringing with them an utterly different mindset. This would create a team composed by members holding very distinct role identities from one another, which would, in turn, have important implications for team functioning and performance.

Future research could, thus, seek to understand the composition of teams that are comprised of members holding different role identities (e.g., teams comprised of a mix of individuals with a pure scientist identity and individuals with a pure commercial identity who have been brought into the team as surrogate entrepreneurs, or members with hybrid identities). It is also interesting to contrast pure team role identities (e.g., science team identity) with hybrid team role identities (e.g., mix of science and business) and their effects on performance.

Turning to a social identity perspective on teams, it would be intriguing to see when teams would embark on a social mission with their ventures rather than pursue "conventional"

commercialization objectives such as attaining financial benefits and personal wealth. In this vein, the studies of Fauchart and Gruber (2011) and Gruber and MacMillan (2017) offer interesting insights on how the identity of entrepreneurs affects the way in which they establish their ventures and what outcomes they seek to accomplish in new venture creation. We believe that research that looks at how ASO teams decide for pursuing a social goal—be it for the benefit of their own community or for society-at-large—could push research to the next frontier. It is these outcomes that tend to be hardly understood, yet that could resolve some of the most pertinent questions that human beings face in today's world. We also believe that the academic audience, in particular, in technology-related domains, is one that is particularly open towards creating start-up firms that serve noble causes. In this regard, the scale developed by Sieger et al. (2016) can help scholars in capturing the social identities of the members of ASO teams.

3.3.2. Formation of the founding team

Extant studies have underscored the idiosyncratic nature of ASO teams, which tend to be characterized by homophily as they team up individuals, who are co-localized and possess similar human capital and shared working experience (Bathelt et al., 2010; Colombo & Piva, 2008). As a result, when they develop their firm competencies, they tend to place more emphasis on technical and scientific functions rather than on commercial ones (Colombo & Piva, 2012).

The existing studies provide useful insights on the factors that differentiate ASOs from other types of ventures, but do little that would help us understand the antecedents of founding team formation within the group of ASOs. Understanding the formation of the initial team at the start-up phase would be critical as the "genetic characteristics" of ASOs have an imprinting effect on firm development (Colombo & Piva, 2012). For example, it would be interesting to study what makes certain ASOs more likely to include members that possess industry or

entrepreneurial experience in their initial founding team compared to ASOs that do not. Specifically, we propose that future research could examine the potential reasons for systematic differences at three levels. First, systematic differences may be observed because of the characteristics of the original inventor such as her human and social capital, identity, or personality. Second, the role of the originating institutions needs to be explored in greater detail, as there is already evidence about their role in coaching ASO teams and attracting surrogate entrepreneurs (Clarysse & Moray, 2004; Franklin et al., 2001). Finally, researchers could examine whether the focal research domain leads to any systematic differences in composing the initial founding team. For instance, scholars can examine whether team formation in IT appears to be significantly different from team formation in biotechnology. In biotechnology, more scientists may initially form the founding team, as spin-offs in this setting are more research intensive, while IT spin-offs may have a marketing function represented in the team right from the start, as they tend to progress more quickly to commercialization.

3.3.3. The role of team functioning

While a lot of attention has been paid to the effects of team attributes on the performance of ASOs, the mechanisms through which these attributes affect performance remain unclear, as only few studies have done work in this direction. Understanding team functioning in this context would be critical, given that ASOs face a number of context-specific challenges that affect the way their members interact and combine efforts to successfully commercialize their technology. For instance, these teams need to combine different "thought worlds" to link a technology to a market (Dougherty, 1992; Gruber et al., 2013): the scientific and the business worlds that are likely to create disagreement about the team's vision and strategy, as well as day-to-day operations. Balancing these two very distinct but equally important mindsets can hinder knowledge sharing, create tensions in the team, or create communication and collaboration problems.

A promising line of research is to examine how knowledge is shared within an ASO team. The studies that focus on the effects of human capital endowments on spin-off performance suggest that combination of individuals with technological and commercial expertise would enhance performance. In essence, it is implied that the knowledge held by these individuals would be uniformly shared within a team allowing academics to grasp the market side of things and managers to understand the technology parameters. However, knowledge sharing does not occur automatically and may prove problematic (Srivastava, Bartol, & Locke, 2006), resulting in sub-optimal utilization of cognitive resources available to the team (Argote, 1999; Mesmer-Magnus & DeChurch, 2009). This may be particularly challenging, when team members represent separate subgroups holding distinct pieces of knowledge. For instance, we expect that the faultlines that occur between academics and surrogate entrepreneurs, based on their different backgrounds, mindsets and identities, would pose significant obstacles to knowledge sharing.

Scholars could also examine when and how conflict arises from the interaction of academics of different academic status or identities, or from the interaction of academic and non-academic team members. This is especially important in light of the evidence that conflict is the primary reason for ASO founders to leave the team (Vanaelst et al., 2006), depriving the team from important tacit knowledge about the technology that is often embodied in the human and relational capital of its original founders. Conflict is likely to arise in diverse teams, especially when they work under high levels of uncertainty. While some task conflict—related to disagreements about the task content—is necessary for decision-makers to arrive at the best available option, high degrees of affective conflict—that arises because of interpersonal incompatibilities—can be detrimental for team communication and information sharing (De Dreu & Weingard, 2003; Jehn, 1995).

In this regard, it would be relevant to understand if there is an "average" team configuration that would lead to an "ideal" balance of conflict and effective contestation of

ideas. In other words, what levels of diversity can lead to superior team functioning? The answer is not evident, as advantages and disadvantages are associated with both homogenous and heterogeneous teams. The ideas of homogeneous teams tend to converge, resulting in group conformity with little task conflict and sub-optimal decision-making (Janis, 1982; 1995). On the contrary, bringing together individuals that come from different backgrounds and that hold different identities can produce a richer exchange of ideas, but may impair group cohesion and spur collaboration problems.

3.3.4. Temporal context

Scholars can bring the temporal context of ASOs to the forefront in three ways: a) by examining the effects of team composition across the different stages of spin-off development, b) by investigating the evolution of the ASO teams and c) by improving our knowledge on how team functioning changes over time.

Extant research has extensively looked at the effects of team attributes on firm performance but has not examined whether these effects differ across the different stages of spin-off development. We expect that this would be the case, since the skills and competences required for the spin-off development would change, as the new venture moves from product development to market launch. In line with our propositions for future research on team composition, we propose that the team's human and social capital endowments, as well as identity, may play out differently over time. For instance, future research could examine whether industry breadth is more beneficial at the initial stages of spin-off development, as this would give space to the team to consider alternative product-market applications, whereas industry depth is more relevant when the spin-off has a more concrete idea about their target market. Accordingly, the type of a team's network contacts is likely to change over time. For example, a team that is primarily composed by scientists may seek for supplementary science knowledge during prototype development, whereas it is more likely to look for complementary

market knowledge as they progress to the development of the market. Finally, team identities may play out differently, as an ASO moves towards market launch. A team possessing founders with pure science role identities could work well for the early stages of the commercialization process but could prove detrimental at later stages that require a deeper understanding and evaluation of the market.

Besides the performance effects of team composition across the different stages of spin-off development, future research can further enhance understanding of team evolution. For instance, research still needs to disentangle when would be the best timing for acquiring a surrogate entrepreneur. We need to understand whether the benefits of involving a surrogate entrepreneur at the very beginning of the spin-off process outweigh the negatives. As prior research has indicated, the early involvement of surrogates can help the ASO to identify a market gap for its technological discovery. Nevertheless, we argue that at this early stage, the surrogate could potentially bias the team towards a market she is more familiar with and as a result, discourage them from considering the full range of potential market applications.

Furthermore, it is worth examining the faultlines that occur when an ASO team evolves. The exit or the addition of influential members can create new faultlines or alter existing ones (Lau & Murnighan, 1998)—that could, in turn, further influence team evolution in the future. For example, the strength of the faultlines would differ if an entrepreneur with industry experience joins the team of four academics, as compared to entering a team composed of two academics and two entrepreneurs. Yet, it would be more complex to delimit the faultlines if the new member had had some prior common experience with the academics due to her participation in university-industry collaboration projects. The similarities with the sub-group of academics might prove stronger, or at least could lessen the attachment of the new member with the sub-group of the entrepreneurs.

In turn, these team member exits and entries will influence team functioning and mechanisms, as the interaction between team members will change. For example, future

research could examine how new member additions affect knowledge sharing and conflict within a team. In particular, it would be intriguing to understand the associated challenges when a team is highly homogeneous, compared to a more heterogeneous team, or when the new entrant is perceived as a similar other (e.g., an academic in a team composed of academics) or a dissimilar other (e.g., a surrogate entrepreneur in a team composed of academics).

3.3.5. The contingent role of technology

The very characteristics of the technology that is commercialized also will need to be considered in order to arrive at a more complete understanding of teams in ASOs. Whereas technologies can be characterized in many ways, scholars have mainly examined differences in commercialization processes arising from distinctions between major fields (e.g., biotechnology, IT, semiconductors). Beyond such broad distinctions, future research could adopt a more fine-grained perspective on technologies and examine dimensions that have a core influence on the tasks and challenges that teams will be faced with when commercializing an invention. For instance, future research could account for the scope of technology. Going back to the resource-based view argument developed by Penrose (1959), technology scope can be seen as being endogenously shaped by the ASO team. In other words, a technology can be wide in its scope as scientists de-link it from the particular application and seek to understand its more generic building blocks (Danneels, 2007). ASOs can therefore opt for developing a technology that ranges from a very specific, "tailored" single product technology to a more generic platform technology with multiple applications (Clarysse et al., 2011). ASOs are more likely to develop platform technologies, as compared to single product technologies, as they tend to originate from basic research. A platform technology offers them the possibility to explore multiple market applications (Gruber et al., 2008) and at the same time incumbents have more difficulties in figuring out what to do with this type of technology (Shane, 2004). Yet, the degree of technology scope can greatly differ across ASOs and we expect that higher

levels of technology scope are likely to pose more significant challenges to a team, as agents will need to engage in heavy search and experimentation both on the technology and on the market side.

For instance, future research could examine whether ASOs that seek to commercialize technologies with high levels of technology scope would be better off if they formed highly diverse teams, composed of scientists and individuals with industry, entrepreneurial and other business-related experience. The answer is not that apparent, as this team composition increases the likelihood that they identify a large spectrum of alternative market opportunities, but it would also limit the workforce that designs and experiments on alternative product prototypes. To disentangle this trade-off, researchers could examine whether a large team size counters this drawback or whether the spin-off teams should better opt for moderate levels of team diversity, while sourcing complementary skills and knowledge from their network partners.

It is also worth examining the evolution of an ASO team under different degrees of technology scope. As a high degree of technology scope creates the potential for multiple product solutions, the competences required for both the technological and market development of the different solutions may vary significantly. Take, for example, 3D printing that can lead to a variety of products applicable in a multitude of industries, from aerospace, to dentistry, and entertainment. This could have important implications for ASO team member exits and entries. For instance, the original inventor may no longer be willing to be part of the team, if the technology takes a turn that significantly departs from her research interests. At the same time, identifying the right type of surrogate entrepreneur can be quite tricky. Surrogates from different backgrounds would be more suitable for different market applications (e.g., aerospace vs. entertainment), but the spin-off may be unable to identify certain promising market applications, before taking the right person(s) on board. In that case, the process of

locating the right surrogate entrepreneur(s) would be highly iterative rather than linear in nature.

Finally, technology scope may affect team functioning, such as conflict. The plethora of potential applications can encourage vivid discussions about the most promising product-market alternative to follow, but can also put additional mental strain on a team. It would thus be interesting to examine whether there are any systematic differences in the level of conflict ASO teams experience for different degrees of technology scope or how conflict mediates the relationship between team composition and firm performance, by comparing ASOs that exploit low vs. high scope technologies.

3.3.6. Methodological approaches

Depending on the research question under study, future research could adopt both qualitative and quantitative research designs. For example, in order to study team identities, initially a qualitative research design would be more suitable, as it allows scholars to capture the different identities (from social identity and role identity perspectives) that emerge, as well as their unique characteristics. Once the phenomenon is sufficiently well understood, quantitative research projects could compare the performance outcomes of different ASO team-level identities or the effects of the same identity across the different phases of the ASO development. Longitudinal research designs, both qualitative and quantitative, would be of value when seeking to track and analyse changes over time, such as team formation and evolution.

There is also an opportunity to reconsider data collection techniques, as the techniques that are frequently employed in extant studies do not allow scholars to capture the complexity of team mechanisms and dynamics. The quantitative studies reviewed in our paper typically administer surveys or use secondary databases to measure the examined constructs. Although this is common practice in the field of management, this type of research design is not always

suitable to study team functioning—which would be essential to advancing our knowledge of the role of teams. Therefore, future research could benefit from adopting data collection techniques from other fields (e.g., human resource management, social psychology, and behavioral economics) that can generate richer data such as laboratory and field experiments, as well as video-recording. The use of information visualization techniques (Meyer, Hoellerer, Jancsary, & van Leewen, 2013) would also add richness to the findings.

A particularly pertinent methodological advancement relates to the use of experiments. Field and laboratory experiments are a powerful tool to uncover and specify complex relationships and to determine causal effects (Colquitt, 2008). Accordingly, experiments are uniquely suited to shed light on the complex, dynamic, and multi-faceted relationships involved in the study of teams in ASOs. For instance, an experimental research design could be employed to advance understanding of the effects of team composition on spin-off performance. By manipulating the identity, experience, or networking ties of members in a team and by providing these teams with one or more performance-related tasks, researchers can observe relevant effects of team composition on performance and unravel whether an optimal team composition exists in this setting.

Finally, understanding technology-related boundary conditions of team effects would also have important methodological implications, as scholars will have to adopt more complex research designs that will encompass data collected from different sources. For instance, such studies may need to combine primary data (e.g., on team characteristics) with secondary data on technology or to code open-ended information from ASOs' websites, brochures, business plans, patent databases or other documents (e.g., in order to assess technology scope).

3.4. Implications for the broader team literature

There are at least two key ways in which research on ASO teams can contribute to the broader team literature. First, ASOs experience several stages of development over a longer period of

time (Vanaelst et al., 2006). ASO teams therefore need to change along with the demands that are placed on them at each of developmental stages. In other words, the empirical setting offered by ASO teams will allow researchers to arrive at a better understanding of how teams change in response to evolving challenges and, ultimately, to address recent calls for more research on the dynamic nature of teams within the broader team literature (Mathieu et al., 2014).

Second, another distinct characteristic of ASOs lies in the strong science role identity of academic entrepreneurs, along with the need to grow the team with surrogate entrepreneurs who bring in experience and knowledge from the business world (Jain et al, 2009; Lockett et al., 2003; Vohora et al., 2004). ASOs thus provide an interesting context to study the identity make-up of entrepreneurial teams, how it evolves and how it shapes outcomes—a phenomenon that cannot be easily investigated in large, established firm settings, where the identity of the organization itself tends to be strong and may override the identity of individuals.

3.5. Conclusion

Our review on teams in ASOs revealed four research themes that have emerged in the literature. Most of the reviewed studies have looked at the attributes of ASO teams, by examining the human and social capital endowments of academics and surrogate entrepreneurs forming the ASO team. Much less attention has been directed to issues surrounding team formation and evolution, while less than a handful of studies focus on team functioning. These studies have already provided some useful insights on the role of teams in ASOs, but much work remains to be done in each of these themes. For instance, more research is needed to examine the factors that drive the heterogeneity in founding teams' initial structure within ASO and a wider population of technology-based new ventures. In similar vein, more research is needed to understand the drivers of professionalization within these teams. Questions of why founding teams look the way they do and how they can be developed to better meet the business demands

of their growing venture are yet to be answered. In addition, more attention needs to be given to the temporal context of ASOs, to the contingent role of the technology commercialized, and the wider environment of the venture.

In this review, we proposed several avenues for future research towards this direction. We organized the identified gaps and future research propositions along several themes. We did not formulate propositions based on the theory mainly because our review has also revealed that the literature in this field is predominantly phenomenon-driven and the theory is yet to be developed. Although the main focus of this review was on ASO, we are certain that the generated insights apply to a wider population of technology-based start-ups. We hope we can motivate scholars to embark on some of the open research questions not only for the sake of new theory development but also to provide guidance to entrepreneurs when striving to bring new technology to the market.

CHAPTER 4: MICRO-FOUNDATIONS OF ORGANIZATIONAL BLUEPRINTS: THE ROLE OF LEAD FOUNDERS' PERSONALITY

Abstract

The present study examines the micro-foundations of organizational blueprints with specific focus on the effects of the lead founder's personality in assembling and structuring the founding team in growth-oriented technology-based start-ups. Basing our hypotheses on person-organization fit theory and the "liabilities of newness" hypothesis, we find that personality traits affect different aspects of the founding team structure, each of which are known to facilitate the long-term success of new ventures. Extraversion, agreeableness and emotional stability reflect an individual's interpersonal disposition and are associated with the starting up with a team. Conscientiousness is reflected in an individual's deliberation and planning and is important for the structural elaboration of the founding team. These findings highlight a new way of looking at entrepreneurs – rather than being "eccentric risk-takers," successful entrepreneurs appear to be socially adept conscientious planners.

Key words: lead founder personality, the Big Five, founding team structure, elaborate structure

4.1. Introduction

Understanding founding team structures is critical as they provide a framework for entrepreneurs to combine and channel their efforts in order to achieve organizational goals. Yet, up to now, little is known about how these structures emerge and what drives the heterogeneity with regard to their design among nascent firms. For instance, it is not clear why some new ventures are founded by teams with a developed functional roles and experience, while others are founded by homogeneous teams with no differentiated functional structure. This is particularly intriguing because, research repeatedly finds that new ventures founded by

large, broadly experienced and formally structured teams are more likely to succeed over time (Eisenhardt & Schoonhoven, 1990; Ferguson, Beckman, & Cohen, 2015; Sine, Mitsuhashi, & Kirsch, 2006). It is hence worthwhile to understand why some nascent firms settle for a less successful team design.

The most prominent attempt to understand formation of founding team structure is the seminal study by Ruef and colleagues (2003) that offers a comprehensive account of the sociological mechanisms yet does not pay close attention to the individual founder. Although the authors highlight the importance of the lead founder in making an implicit choice of whether or not to engage others in the founding process, and in the "decision regarding *who* will participate and *what* they will contribute" (Ruef, Aldrich, & Carter, 2003; p.195), they do not explore how an individual's characteristics may influence these decisions. The aim of the current study is to contribute to this line of research by elucidating the role of lead founder's personality in forming and structuring a founding team[12].

Extant research shows that personality traits – as captured by the five-factor model (McCrae & Costa, 1987; 1992) – affect a leader's strategic decision making (Nadkarni & Herrmann, 2010; Peterson, Smith, Martorana, & Owens, 2003) and action (Herrmann & Nadkarni, 2014), both of which are likely to have implications for new venture success. However, existing studies have examined the influence of lead founders on new venture performance without considering the intermediary outcomes of the very formation of the founding team. The personality (Ciavarella, Buchholtz, Riordan, Gatewood, & Stokes, 2004; Zhao, Seibert, & Lumpkin, 2010) and entrepreneurial cognition (Ardichvili, Cardozo, & Ray, 2003; Mitchell et al., 2002; Mitchell et al., 2007) literatures have suggested psychological mechanisms, which may explain how the disposition of lead founders affects their propensity

[12] Although some new ventures may be initiated by a group of founders with equal control and decision power, research shows that a clear majority of new ventures has one single core founder who takes on the leading role in the venture creation process (Ensley, Carland, & Carland, 2000; Wasserman, 2012; 2017). In the methods section, we describe how we empirically identified the lead founder.

to work in a team context, even at the expense of retaining full control over their venture (Wasserman, 2012; 2017). They may further explain the differences with regard to how founders choose to organize teams' collective efforts.

From an individual perspective, assembling a functionally developed team involves both the propensity to work effectively in a team context and the ability to organize team members' activities strategically. We therefore distinguish between personality traits that highlight lead founders' (1) interpersonal disposition and (2) deliberate planning. Extraversion, agreeableness, and emotional stability are personality traits that have been associated with interpersonal skills (Barrick & Mount, 1991; Mount, Barrick & Stewart, 1998) and are found to be particularly critical in the context of teams (Morgeson, Reider, & Campion, 2005). Conscientiousness[13] refers to the personality trait that is strongly associated with thorough organization and long-term planning (DeJong, Song, & Song, 2013; Zhao, Seibert, & Lumpkin, 2010). These sets of personality traits are likely to affect the two most salient features of a founding team's structure that have been deemed important for a new venture's development and performance over time: (1) founding by team (as opposed to a solo entrepreneur) and (2) the team's structural elaboration – the degree to which the team comprises a broad set of formally-defined functional roles, and the broad set of experiences that enables team members to fulfil these roles[14]. Because the degree of structural elaboration in a team is conditional on whether the lead founder decides to start up with a team, we employ a two-stage approach. In the first stage, we propose that lead founders with high interpersonal disposition are more likely to start their business with a team rather than be lone entrepreneurs. In the second stage, we

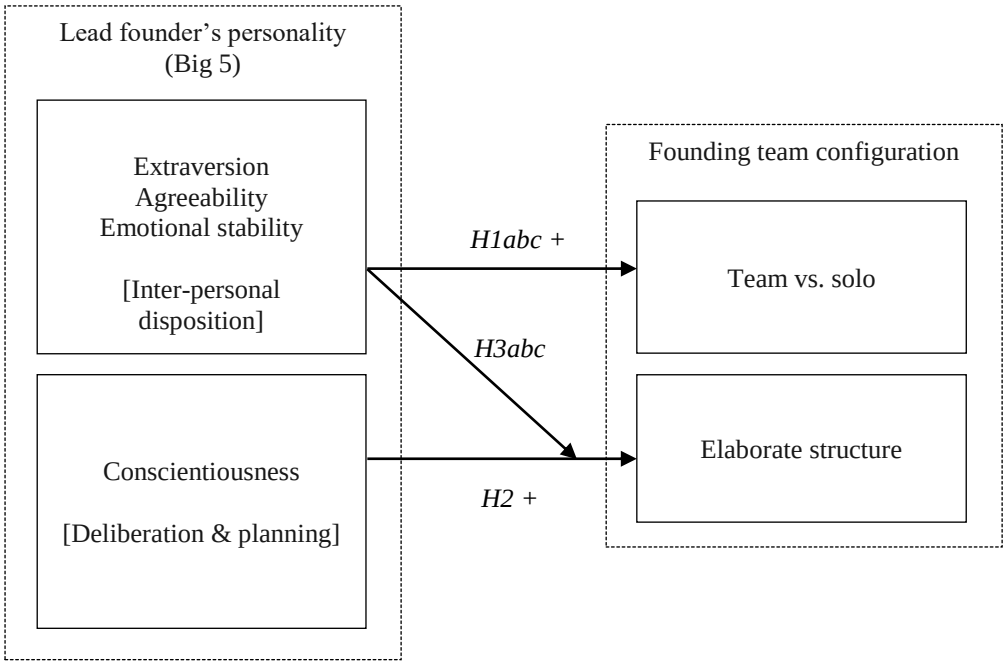
[13] We did not incorporate Openness to experience in our main model, as we did not find sufficient theoretical and empirical support that it is related to either interpersonal disposition or strategic planning in teams. We did however, include it in our control and supplementary analyses.

[14] It needs to be noted that some new ventures may not aspire to grow and hence starting up with a team and developing its structure may not be of interest for these firms. The specific focus of our study is on growth-oriented technology-based start-ups, at the core of which lies technological innovation. These firms are innovative by default but suffer from the liabilities of newness due to the lack of established structures. They therefore benefit (unlike large established organizations) from implementing more formalized structures within their team (Stinchcombe, 1965; Sine et al., 2006).

focus on the sub-sample of firms that were founded by teams and examine the role of lead founders' conscientiousness in promoting structural elaboration within their team. In order to provide support to our claims based on prior research findings that founding teams' structure facilitates new ventures' long-term success (Beckman & Burton, 2008; Sine et al., 2006).

The theoretical basis of this study is person-environment fit (also known as person-organization fit) theory (Judge & Kristof-Brown, 2004; Kristof-Brown, Zimmerman, & Johnson, 2005), which suggests individuals choose their work environments based on their personality, values and needs. While this theory was initially used to study the fit of individuals with pre-existing structures (Chatman, 1991), it has also been applied recently to broader contexts, such as engagement in an entrepreneurial process (Zhao & Seibert, 2006) and person-team configurations (Ferguson et al., 2015). We build on the main premise of this theory that individuals seek to achieve a fit between their dispositional traits and their work environment (Zhao et al., 2010) and we suggest that entrepreneurs are likely to actively design organizational structures in the way that fits their ideals embedded in their personality traits. In sum, we expect that individuals with a high interpersonal disposition are more prone to working in a social context and therefore are more likely to start up with a team. Conditional on starting up with a team, we expect conscientious lead founders to be more prone to implementing an elaborate team structure. Based on prior research, we further expect new ventures that start up with a team and elaborate founding team structure to be more likely to complete critical organizational milestones. Figure 4.1 summarizes our conceptual model.

Figure 4.1. Research model



4.2. Theoretical development

Upper echelons (Hambrick, 2007; Hambrick & Mason, 1984) and CEO research (Hiller & Hambrick, 2005) suggest that the individual characteristics of CEOs influence the strategic decisions of organizations. Particularly within the context of new ventures, where entrepreneur's managerial discretion and latitude of action are at higher levels than in most other teams and organizations (Hambrick & Abrahamson, 1995; Klotz, Hmieleski, Bradley, & Busenitz, 2014), leaders' preferences, experience and behavior have significant effects on the choice and continuation of the initial structures. Although there is a variety of individual attributes that are known to influence organizational choices, a long history of research in the field of personality psychology was able to generate a robust and comprehensive taxonomy of fundamental personality differences – the "Big Five"[15] (John, Naumann & Soto, 2008; Peterson

[15] In the present study, we use a five-factors model, as opposed to the six factors, as at the time of our first round of data collection the Hexaco models (Ashton & Lee, 2007; 2008) were not yet widely used.

et al., 2003). This framework distinguishes between individuals' personality types classified along five dimensions: extraversion, agreeableness, openness to experience, conscientiousness, and neuroticism (Barrick & Mount, 1991; McCrae & Costa, 1992). Each of these personality traits reflects a set of preferences and drives in an individual (Allport, 1937; Zillig, Hemenover, & Dienstbier, 2002; Wiggins & Trapnell, 1997) that are known to relate to the individual's personal choices (Baum & Locke, 2004; Baum, Locke, & Smith, 2001) but also to the strategies, structures and performance of the organizations they lead (Hambrick & Mason, 1984; Nadkarni & Herrmann, 2010). The five-factor model offers a robust and comprehensive psychological framework for understanding fundamental personality differences and their effects on strategic decision making (Peterson et al., 2003).

Although by the late 1980s, unable to establish a consistent relationship between personality and entrepreneurship, reviewers had prematurely concluded a discontinuation of this line of work (e.g., Brockhaus & Horwitz, 1986; Gartner, 1988), recent meta-analyses provide strong evidence for the predictive validity of personality traits in entrepreneurship research (Collins, Hanges, & Locke, 2004; Stewart & Roth, 2001, 2007; Zhao & Seibert, 2006; Zhao et al., 2010) and call for further analysis of the contingencies and intermediary mechanisms that impact this relationship. Conceptual and methodological advancements, particularly in the use of more complex models, meta-analyses, robust taxonomy of the personality traits (the Big Five) and concepts that closer reflect performance in terms of causality, have spurred a new wave of scholarly interest in personality and entrepreneurial processes (e.g., Baum & Locke, 2004; Ciavarella et al., 2004; DeJong et al., 2013), enabling more robust and rigorous research. While the recent meta-analyses confirm the importance of personality traits in entrepreneurship success (Zhao et al., 2010),

empirical work typically focuses on the mechanisms that reflect the propensity of individuals to perform entrepreneurial tasks successfully, without paying sufficient attention to the intermediary and more proximal outcomes that may facilitate this success. With the

strong focus on an entrepreneur's need for achievement (Rauch & Frese, 2005) and risk-taking (Stewart & Roth, 2001), extant research tends to overlook the social aspect of a new venture creation and the qualities it takes to assemble an effective and resourceful team.

In the current study we aim to extend our understanding of the role of personality in the entrepreneurial process, by focusing on how lead founders' personality attributes affect founding team formation. Hereby, we first focus on those among the lead founder's traits that reflect interpersonal disposition, as "new organizations are clearly social entities from the beginning, as even solo founders implicitly make choices – or face constraints – that lead them not to cooperate with others in the founding process" (Ruef et al., 2003, p. 196). Hence, we propose that lead founder's propensity to work effectively in a team context will either predispose or constrain the choice of founding with a team. Second, entrepreneurial activity requires a high degree of conscientiousness, as designing a viable organization with growth prospects involves thorough planning about how to assemble resources, organize human capital, establish communication channels, distribute tasks and assign organizational roles. We therefore focus on conscientiousness as the personality trait most related to an individual's organization and planning (Barrick, Mount, & Judge, 2001; Zhao & Seibert, 2006), and as the one most likely to affect a lead founder's propensity to develop an elaborate structure to organize the team.

These qualities have been widely understated by the general entrepreneurship research, despite the strong evidence that new ventures founded by teams have higher survival rates (Aspelund, Berg-Utby, & Skjevdal, 2005), and that founding teams with higher levels of structuring are more likely to grow (Sine et al., 2006), obtain venture capital (Beckman & Burton, 2008), and achieve initial public offering (Beckman et al., 2007). Teams, as opposed to a lone entrepreneur, enjoy access to more human and social capital resources (Hambrick & D'Aveni, 1992), while having a more developed structure helps new ventures to overcome the liabilities of newness (Stinchcombe, 1965). Unlike large established firms, in which structures

impede their ability to innovate, growth-oriented technology-based new ventures are innovative by default, as innovation is the primary reason for their very existence. Formalized structures within these ventures are beneficial as they enable organizational decision making, individual focus, learning and efficiency, while reducing complexity and work ambiguity (Perrow, 1986; Sine et al., 2006). Furthermore, recent studies show that the professionalization process beyond the founding stage may be constrained by the founding condition as a result of path-dependency (Gruber, 2010), homophily (Ruef et al., 2003) and inertia (Phillips, 2005).

For instance, in a longitudinal study of technology-based new ventures in the Silicon Valley, Beckman and Burton (2008) found that narrowly structured and narrowly experienced founding teams were less likely to develop their role structure or their experience over time and that this decreased their likelihood to obtain VC and initial public offering. We build on these insights to suggest that the founding team's structure is an important intermediary outcome in the new venture creation process, and that choices of *whether* others will join the team and, more importantly, *who* will join and *what* they will contribute can have lasting consequences for new venture's development, survival and success.

As our theoretical basis we build on the person—environment fit theory (Judge & Kristof-Brown, 2004; Kristof-Brown et al., 2005) to suggest that individuals choose their work environments in congruence with their personality, values and needs (Zhao et al., 2010). Applying this logic to the formation of the entrepreneurial firm, we expect individuals who score highly on personality traits related to interpersonal disposition to be more likely to found a new venture with a team (as opposed to becoming a solo entrepreneur).

This is because these individuals are more motivated to engage in the type of behaviors that involve social interaction. They do so effortlessly, with more commitment, satisfaction and success. In other words, their *motivation*, *ability* and *opportunity* to engage in social interactions make the team-based work-setting more attractive. Similarly, we expect individuals scoring highly on conscientiousness to be more likely to elaborately structure the

team, as they have higher motivation, ability and opportunity to engage in behaviors that involve an eye for detail and planning. In sum, we expect personality to affect lead founders' decisions about the founding team due to their motivation, ability, and opportunity to engage in certain types of behaviors.

In the following sections, we formulate our hypotheses. First, we examine the effects of personality traits, highlighting the effect of interpersonal disposition on a lead founder's choice to assemble a team. Next, we highlight the role of conscientiousness in setting up an elaborate team structure, followed by an examination of the interplay between lead founders' conscientiousness and interpersonal disposition.

4.2.1. Interpersonal disposition and founding by a team

Founding with a team depends on whether the individual's perceived benefits of cooperating with others outweigh the perceived threats. Benefits include the increased human and social capital (Clarysse & Moray, 2004; Colombo & Grilli, 2010; Colombo & Grilli, 2005) necessary to achieve important milestones, a larger knowledge pool and specialization in decision making (Eisenhardt & Schoonoven, 1990), but also the reduced workload and complexity that comes from the division of tasks and responsibilities (Perrow, 1986; Sine et al., 2006). The threats arise from the need to give up equity and control over one's venture (Wasserman, 2012; 2017). While the precise benefits and threats of starting a new venture with a team depend on a wide range of situational factors that are difficult to predict, depending on their personality traits individuals may have stronger preferences and predispositions towards certain behaviors and situations.

An important and distinguishing feature of starting up a venture with a team, as opposed to as a solo entrepreneur, is the need for the individuals to have the motivation, ability and opportunity to work effectively with others. A variety of interpersonal skills increase in importance when a leader decides to set up a team. These skills include the ability to instill

trust, to communicate effectively with others and listen to them, as well as to read accurately, influence and persuade other people (Baron & Markman, 2000; Mohrman & Cohen, 1995; Morgeson et al., 2005). The following paragraphs describe personality traits that prior research has associated with these skills: extraversion, agreeableness and emotional stability. We propose that they enhance lead founders' propensity to set up a team, as well as to successfully manage it throughout the trial period before founding a new venture collectively.

Extraversion. Extraversion describes individuals characterized by assertiveness and sociability (McCrae & Costa, 1987). Extravert leaders tend to be active and take initiative (Barrick & Mount, 1991), they are socially engaging and charismatic (Judge, Bono, Ilies, & Gerhardt, 2002; House & Howell, 1992). This helps them build wide and diverse networks of social relationships, from which they can draw while assembling resources and building a team. As highly articulated and assertive individuals, they have strong persuasive skills (Judge et al., 2002) that may help them to convince others to join their team. Because extravert individuals have a strong need for sociability, we expect them to prefer working in teams rather than as a lone entrepreneur. Due to their charisma and broad social network, they are also likely to be able to attract and retain potential partners to join their team. Introvert individuals, on the other hand, are quite, more reserved and less sociable (McCrae & Costa, 1987). Lack of persuasiveness and expression of introvert founders makes it difficult but also less desirable for them to form a team. In sum, we propose that the charisma, broad social network and strong need for sociability of extravert founders provides them with the necessary motivation, ability and opportunity to work in a team context.

Hypothesis 1a. Extraversion is positively related to starting up with a team, as opposed to being a solo entrepreneur.

Agreeableness. Agreeableness describes individuals characterized by trust, altruism, cooperation and modesty (Zhao et al., 2010). Agreeable individuals show sympathy, kindness and consideration for the needs of others (Costa & McCrae, 1992). They tend to be compromise-seeking, deferring to others and dealing with conflict in a collaborative way (Digman, 1990; Zhao et al., 2010). Highly agreeable leaders build highly cohesive teams, in which they tend to de-emphasize status and power asymmetries, they encourage discussion and information exchange among the individual team members to reach group consensus (Peterson et al., 2003). The kind and compromise-seeking nature of agreeable individuals makes it easy and more attractive for them to work in teams. Conversely, it also attracts potential partners to join the team, as working closely with these individuals is perceived as pleasant and reliable. Highly disagreeable individuals, in contrast, tend to be selfish, stubborn, rude and generally have little patience with others (McCrae & Costa, 1987). Their conflictful and callous nature makes it difficult for them, but also for the others to work together in a team setting. In sum, we propose that the collaborative, trustful, and compromise-seeking nature of agreeable founders provides them with the necessary motivation, ability and opportunity to work in a team-based setting.

Hypothesis 1b. Agreeableness is positively related to starting up with a team, as opposed to being a solo entrepreneur.

Emotional stability. Emotional stability characterizes individuals who are calm, even-tempered, and relaxed as opposed to being anxious, compulsive, defensive, and thin-skinned (McCrae & Costa, 1987). Individuals high on emotional stability tend to be good at handling stress, while maintaining composure and self-confidence across different situations (Morgeson et al., 2005). Ability to tolerate stress allows emotionally stable leaders to better manage complex and ambiguous situations (Morgeson et al., 2005). They are more likely to engage in

helping behaviors (Porter et al., 2003), to "get along" with their counterparts (Hogan & Holland, 2003), and to have more developed teamwork skills (Hough, 1992). In contrast, emotionally unstable (neurotic) individuals are less cooperative, more likely to express negative attitudes and exhibit poor quality interactions with colleagues (LePine & Van Dyne, 2001). This makes it very unlikely for unstable leaders to be either willing or able to attract and retain potential partners. In sum, we propose that the positive, even-tempered, and confident nature of emotionally stable founders provides them with the necessary motivation, ability and opportunity to work in a team.

Hypothesis 1c. Emotional stability is positively related to starting up with a team, as opposed to being a solo entrepreneur.

4.2.2. Conscientiousness and elaborate founding team structure

"The emergence of a new formal organization invariably entails a decision regarding who will participate and what they will contribute" (Ruef et al., 2003, p. 195), both of which may have lasting effects on new venture survival and success. We therefore examine the effects of lead founders' personality on their propensity to assemble a founding team that comprises both structural aspects of the founding team (the who and the what). Building on the established tradition of top management team demography research and the upper echelons perspective, we distinguish between two team characteristics: (1) founders' functional role assignments, and (2) founders' functional experience (Beckman & Burton, 2008; Bunderson & Sutcliffe, 2002). Functional role assignments refer to the existence of specific functional positions within the team, while founders' functional experience refers to the human capital of each of the individual founders (Beckman & Burton, 2008; Ferguson et al., 2015). Although conceptually and empirically different (Beckman & Burton, 2011; Bunderson & Sutcliffe, 2002; Crossland, Zyung, Hiller, & Hambrick, 2013; Ferguson et al., 2015), each of the two represents an

important element of a founding team structure. We therefore examine them in combination and coin the term elaborate structure to describe founding teams that comprise both clear distribution of functional tasks and a broad set of experiences that would enable individuals to successfully complete these tasks.

The degree to which the lead founder is likely to adopt an elaborate structure in the founding team depends on his or her propensity to engage in thorough structuring and long-term planning – the qualities that are best reflected by individuals' conscientiousness (Anderson, Spataro, Flynn, 2008; Barrick & Mount, 1991). Lead founders with a high motivation, ability and opportunity to engage in thorough detail-driven planning and structuring of organizational tasks are more likely to identify all relevant operational domains of their venture and strive to staff them with the relevant expertise. We therefore propose that highly conscientious founders starting up with a team are more likely to elaborately structure their founding team.

Conscientiousness describes individuals characterized by high sense of organization, responsibility, deliberation, and achievement-orientation (Barrick & Mount, 1991; Bono & Judge, 2004; Costa & McCrae, 1992). Conscientious individuals tend to be planful, efficient, detail-oriented, and thorough in their work (Anderson et al., 2008). They are also known to be more persevering and attentive to tasks (McCrae & Costa, 1987; Peterson et al., 2003), and this makes conscientiousness the most consistent predictor of job performance across all types of work and occupations (Barrick et al., 2001) and particularly those involving managing others (Barrick & Mount, 1991).

Having an eye for detail and planning allows conscientious lead founders to carefully identify critical functional domains and individual tasks important for new ventures' long-term development, as well as the experience that is necessary to fulfil these tasks. Furthermore, they are more likely to strive to organize the activities of their team in a more structured and efficient way. For instance, Zhao and Seibert (2006) suggested that achievement-oriented and well-

organized conscientious entrepreneurs would develop more detailed plans and strategies in order to demonstrate their ability to successfully fulfil entrepreneurial tasks (Zhao & Seibert, 2006). In another study of lead founders' personality, DeJong and colleagues (2013) proposed that conscientious lead founders would initiate structures and set rules that guide team members' efforts effectively while decreasing potential conflict. Conscientious lead founders have a preference for unambiguous, structured work settings (Costa & McCrae, 1988; DeJong et al., 2013). In an effort to control the uncertainty associated with establishing a new business, conscientious entrepreneurs tend to highly structure their environment (Peterson et al., 2003). We therefore expect conscientious leaders to assemble founding teams that are elaborately structured – including a broad range of formalized functional tasks to foster coordination and experience that would enable team members to effectively fulfil their tasks.

Hypothesis 2. Conscientiousness is positively related to the founding team's elaborate structure

4.2.3. Conscientiousness and Interpersonal disposition

Conscientiousness may be essential for identifying critical functional domains and individual tasks within these domains that need to be covered by the team. However, this trait alone may not ensure that the roles identified are filled by the right people, as highly conscientious individuals tend to focus on the tasks, rather than on interpersonal relationships (McCrae & Costa, 1987), and this may make it difficult to attract the desired human capital to join the team. Particularly in the context of new ventures, which are typically resource constrained and may not be able to offer salaries competitive to those of the resourceful established firms (Ferguson et al., 2015), social skills may be essential to attract highly-skilled human capital. We therefore propose that leaders characterized by personality traits that are associated with

both a high degree of conscientiousness and high degree of interpersonal disposition would be more likely to form elaborate teams.

First, conscientious individuals do not necessarily possess the appropriate social capital to ensure that the gaps identified are filled by individuals with the relevant expertise. However, highly conscientious extraverts – who are enterprising, firm, persistent and vigorous (Witt, 2002) – may benefit from a broad social capital from which they can draw and enables them to attract the right people to fill the required roles and provide the experience needed. Conscientious leaders who also exhibit high degree of sociability, persuasiveness and charisma would also find it easier to convince the right people to join the team. In contrast, highly conscientious introverts – who are cautious, conservative and reserved (Witt, 2002) – may not be interested in working in teams, as the costs of social interaction perceived by an introvert individual may outweigh the benefits of covering all the necessary task domains that the conscientious individual perceives. In sum, we propose that the tendency to be sociable and charismatic (i.e. extravert) makes conscientious lead founders even more likely to assemble a structurally elaborate founding team.

Hypothesis 3a. The positive effects of conscientiousness on the founding team's elaborate structure are stronger for extravert leaders.

Second, conscientious founders who are also agreeable are likely to be more effective. Their deliberation and task-focus makes it easier for them to identify the relevant positions and expertise to be filled by potential partners, while their kind compromise-seeking nature, helpfulness and cooperation makes it easy for them to work with other, but also makes them very attractive to work with (Witt et al., 2002). In contrast, conscientious but highly disagreeable founders may be perceived by others as not trustworthy and even as unpleasant to work with – they may appear as micro-managing, unreasonably demanding, inflexible and rude

(Witt, Burke, Barrick, & Mount, 2002). In sum, the tendency to be cooperative, considerate, and trusting (i.e., agreeable) makes conscientious leaders even more likely to assemble a structurally elaborate team.

Hypothesis 3b. The positive effects of conscientiousness on the founding team's elaborate structure are stronger for agreeable leaders.

Third, conscientious and emotionally stable leaders are more likely to be positive and confident in their ability to structure their organization, which in turn signals strong leadership and reliability and makes it attractive for others to join the team. In contrast, conscientious yet emotionally instable founders may feel overwhelmed by the complexity of the entrepreneurial task – and even more so by the responsibilities of managing others – and this could impair the climate and the general functioning of the team (Hatfield et al., 1994). The negative affect of emotionally instable individuals is likely to be amplified by high pressure to perform – typical for conscientious individuals – making individuals with this particular combination of personality traits very vulnerable to emotional exhaustion (Witt, Andrews, & Carlson, 2004). In sum, the tendency to be confident and even-tempered (i.e., emotionally stable) makes conscientious leaders even more likely to assemble a structurally elaborate team.

Hypothesis 3c. The positive effects of conscientiousness on the founding team's elaborate structure are stronger for emotionally stable leaders.

4.3. Data and methods

4.3.1. Sample

We test our hypotheses in a sample of 148 technology-based new ventures founded in Flanders between 2006 and 2011. The population of technology-based start-ups in Flanders was identified through the IWT, the Flemish Agency for Innovation by Science and Technology, which aims at supporting innovation in Flanders, both within academia and industry. The technology-based entrepreneurship community in Flanders is rather small, with the majority of founders applying for IWT funds and making use of the agency's supportive activities, including information sessions and networking events. IWT has endorsed our study and provided us with the lists of new ventures and their contact information, including successful and non-successful applicants for seed funds. Using these lists, the annual data collection was conducted from 2009. We have recorded general information about these ventures (including founding year, sector, profitability, legal type) using BELFIRST database. Companies that were older than 3 years at the time of the first observation were eliminated from the sample. This resulted in a total of 258 companies being identified and contacted over the course of 5 years. Out of this total number of firms, 169 (66%) participated in the study by completing a questionnaire at some point of time. Due to the missing information, the final dataset includes 148 firms. Our key variable of lead founder personality was assessed via a survey, while most remaining information about the start-ups and their founders was obtained via secondary data collection sources, and this allowed us to keep track annually of the companies and to record important organizational changes. Our key dependent variables (and some independent variables) were constructed from founders' career histories. We constructed a large-scale database of each founder's demographic and career-related information using secondary data sources (e.g., LinkedIn, Bloomberg, firms' websites, and press releases) in combination with the primary data-collection (interviews with the founders). We record prior employment

information and the initial job title of every founder in each of the sampled firms, resulting in a database of 382 founders.

4.3.2. Analysis

In order to model the effects of the lead founders' personality on the founding team structure, we first need to address a potential selection bias. Sample selection issues arise when the population of interest stems from a non-random sub-sample of the wider population and when the observations are not independent of the outcome of interest. In our study, the founding team structure is conditional on whether there is a founding team. Hence, accounting for the selection into team-based founding is critical, as it may affect our results. To control for this potential selection bias, we run a Heckman two-step model (Heckman, 1976). This approach involves estimation of a first-step probit model for selection, followed by the insertion of a correction factor—the inverse Mills ratio (IMR), computed from the first-step probit model—into the second-step linear regression model of interest (Heckman, 1976).

In our study, step one (selection model) involves estimating the propensity to start-up with a team (as opposed to being a solo entrepreneur) using a probit model. This analysis is performed on the full sample of firms (N=148). Step two (linear regression model) is conditional on the first step and involves estimating the elaborate structure of the founding team with the coefficients adjusted according to the results of the first step. We use the ordinary least square (OLS) regression on the sub-set of firms (N=91) that were founded by teams (as opposed to one single entrepreneur). This method allows us to investigate not only the determinants of structure in founding teams, but also the determinants of founding with a team – which in itself has been considered an important antecedent of new venture success.

The effectiveness of this approach relies on whether we can identify instrument variables (i.e., exclusion restriction variables) in the first-step (team vs. solo) equation that do not plausibly influence the second-step outcomes (founding teams' elaborate structure). Doing

so minimizes the confounding regression function misspecification problems. We include two exclusion restriction variables: (1) new ventures' entry mode (university spin-off) and (2) lead founders' prior commercial experience – both of which are likely to affect the size (i.e., starting with a team as opposed to being a solo entrepreneur) but not the structure of the team. Table 4.1 provides an overview of the methods (incl. analyses, variables, sample size) we performed.

Table 4.1. Methods overview: Variables, analysis, sample size

	Dependent variable	Predictors	Controls	Analysis	N
Step 1 (Full dataset)	Team vs. solo (1/0)	Extraversion Agreeableness Emotional stability (Interpersonal disposition)	Founding year (crisis) University spin-off Product LF commercial exper.	Probit	148
Step 2 (Subsample of team-based firms)	FT elaborate structure	Conscientiousness C X Extraversion C X Agreeableness C X Emotional stability (Conscientiousness X Interpersonal disposition)	Founding year (crisis) Product FT size (log) IMR	Heckman selection model OLS	91

4.3.3. Dependent variables

In this study, we examine two types of dependent variables related to founding team structure: (1) team-based founding and (2) founding team's elaborate structure. These are the conditions that have been deemed relevant for the long-term success of new ventures by prior research (e.g., Beckman & Burton, 2008; Colombo & Grilli, 2005; 2010). In line with De Jong and colleagues (2013), we define the founding team as the group of entrepreneurs who jointly incorporated the venture.

Team-based founding. We code whether the new venture was incorporated by a founding team, as opposed to a single founder. We use a dummy variable with the value 0 if the venture was founded by a single entrepreneur and a value 1 if it was founded by at least

two founders. Consistent with the literature, the majority of new ventures within our sample were founded by teams, rather than by a lone entrepreneur. Out of the total of 148 new ventures, 91 (61%) were founded by teams. The founding team size varies from two to seven founders. Table 2 depicts the descriptive statistics for the first stage model predicting team-based founding.

Founding team's elaborate structure. Teams with elaborate structure comprise a wide set of functional roles, and broad set of experience that allows individuals to fulfill these roles effectively. We therefore define an elaborate team structure as a structure in which breadth of roles and breadth of experience are both high. Breadth of roles and breadth of experience are two measures that are frequently used in the top management team research to examine the team (Beckman & Burton, 2008; Bunderson & Sutcliffe, 2002). Breadth of roles denotes whether a team has a broad set of formalized functional roles, while breadth of experience assesses the human capital of the team members. Although most prior research uses the two team characteristics interchangeably or in isolation from one another, each of the two represents an important element of a founding team structure and should therefore be examined conjointly (Beckman & Burton, 2008). We therefore examine breadth of roles and breadth of experience in combination with one another and coin the term elaborate structure to describe founding teams that comprise both clear distribution of functional tasks and a broad set of experiences that would enable individuals to successfully complete these tasks. The measure is constructed by averaging breadth of roles and breadth of experience after initially standardizing the two[16]. In the following sections, we describe how we operationalized each of these measures.

Founding team's breadth of functional roles. We use a count measure assessing whether the firm has defined positions within the team that correspond to the seven functional

[16] We performed a number of robustness analyses with each of these separate measures (See Appendix, Table B and Table C).

areas: (1) general management, (2) science/R&D/ICT/engineering, (3) sales and marketing, (4) manufacturing and operations, (5) finance/accounting, (6) strategic planning/business development, and (7) law and administration (including HR). These areas were also identified by prior research as important components of technology-based firms' functional structure (e.g., Beckman & Burton, 2008; Boeker & Wiltbank, 2005), signaling how developed the functional structure of a given firm is.

For each venture, we record how many functional domains are covered by the positions within the founding team. For example, if a founding team consists of a CEO, Director of Discovery Research, Director of Marketing, and a Director of Business Development, this team has four established functions (general management, science/R&D/ICT/engineering, sales/ marketing, and strategic planning/business development) at the time of founding. Conversely, if the team consists of a CEO, Director of Discovery Research, Senior Director of Technology Development, and a Vice President in R&D, this team has two established functions (general management and science/R&D/ICT/engineering). Within our sample of team-founded firms, the minimum of formal functional roles is one (if all team members are general partners or scientific managers) and the maximum is four. The vast majority of firms has two functional roles at founding – typically within general management (CEO) and a technical domain (IT, R&D) domains. Table 3 depicts the descriptive statistics for the second stage model.

Founding team's breadth of functional experience. We gathered information about founders' prior work experience from career histories. In line with prior research, we assess whether each of the founders has had prior functional experience in the aforementioned seven functional areas. We code up to three prior positions for every individual within these domains. For example, one of the founding teams in our sample includes four members with the following prior functional experiences. Before starting the venture of our focus, the first member founded three firms that they led as a Chief Executive Officer (general management), three firms. The second founder worked as a managing director (general management) in a

large consulting firm, founded and led one venture (general management), and worked as project manager (general management) in a large global science-based company active in health nutrition and materials. The third founder worked as a software designer (science/R&D/ICT/engineering) in a medium-sized information technology firm and as software designer (science/R&D/ICT/engineering) in a large electronics multinational. The fourth founder worked as a managing director (general management) in a medium-sized information technology firm and as strategic business developer (business development/ strategic planning) in a large multinational. This founding team has functional experience in general management, science/R&D/ICT/engineering, and business development/ strategic planning. Within our sample, the minimum count of functional experience within the founding team is 0 (freshly graduated students or college drop-outs with no prior working experience) and the maximum is 4. The vast majority of the founders have two functional experiences – typically within the technical and general management domains (See Table 3 for descriptive statistics for the second stage model).

4.3.4. Independent variables

Following De Jong and colleagues (2013), we define the lead founder as "the lead entrepreneur who initiated the new venture and assembled the new venture founding team" (p.1835). The lead founder takes on the most prominent role in his or her venture and is responsible for most of the initial decision making (De Jong et al., 2013). We established the identity of the lead founder through consultation with respondents. This information was then confirmed through the secondary data sources (e.g., company's web pages, incorporation files). In all companies within our dataset we were able to establish that one of the founders was undertaking the leading role in new venture's activities and its strategic decisions, including the formation of the team. We administered the personality questionnaire to this person.

Lead founder's personality. To measure lead founder's personality, we used the Big Five Inventory (BFI) of John, Donahue and Kentle (1991), as modified and tested by Soto and John (2009). All items were assessed by the means of the seven-point Likert scale. Extraversion was assessed by the means of eight items measuring the degree of the lead founder's expressiveness and sociability. Examples of items include "I am outgoing, sociable", "I am talkative", "I am reserved (R)". The reliability of this scale is α= .84. The conscientiousness measure comprises nine items assessing whether the lead founder is thorough, well organized, efficient, planful, and focused. Examples of items include "I persevere until the task is finished", "I make plans and follows through with them", "I can be somewhat careless (R)". The reliability of conscientiousness is α = .72. Agreeableness consists of nine items measuring whether the lead founder is trusting, helping and forgiving. Examples of items include "I am generally trusting", "I am sometimes rude to others (R)", "I tend to find fault with others (R)". The reliability of this scale is α=.73. The emotional stability scale consists of eight items assessing whether the lead founder is tense, anxious, or compulsive. Examples of items include "I am depressed, blue (R)", "I worry a lot (R)", "I can be tense (R)". The reliability of this scale is α= .80.

Although, we did not include it in our main analysis, we also measured the lead founder's openness to experience, and performed supplementary analyses to eliminate potential confounding. Openness to experience consists of 10 items measuring whether the lead founder is original, curious, ingenious, imaginative, inventive, and reflective. Examples of items include "I am someone who is original, comes up with new ideas", "I am someone who prefers work that is routine (R)", "I am someone who likes to reflect, play with ideas". The reliability of this scale is α= .82.

All five scales of the Big Five questionnaire were subjected to a confirmatory factor analysis to test the extent to which the five-factor scales adequately represent the covariance matrix of the data. Confirmatory factor analysis (CFA) is the most appropriate tool for

confirming whether construct measures load on their respective a priori defined factors (Browne & Cudek, 1993). The range of loadings for the five personality factors were: conscientiousness, .38 to .78; extraversion, .34 to .75; agreeableness, .38 to .63; emotional stability, .31 to .75; and openness to experience, .34 to .78 (See Appendix, Table E)[17]. Overall, the CFA along with the high reliability scores indicate the strong validity of our personality measure.

4.3.5. Control variables

We include a number of control variables that have been found by prior research to be important for team formation and new venture success. Due to the limited degree of freedom (particularly in our second stage model), we were careful in selecting control variables. Our first-step model (selection model) has the largest degree of freedom and includes following control variables: year of founding, product vs. service, university spin-off, and lead founders' prior commercial experience. Thereby, university spin-off, and lead founders' prior commercial experience are the exclusion restriction variables – instrument variables that affect the first-step, but not the second-step, outcomes – and are therefore not included in the second-step regression model. Our second-step model includes following control variables: year of founding, product vs. service, and inverse Mill's ratio (IMR). Our Cox proportional hazard model has a limited number of events, leading to a very careful consideration of control variables. The overview of which control variables are used in each of the models is depicted in Table 1.

Year of founding. To control for the general economic and environmental conditions at the time of founding, we include a dummy variable with the value 1 for all ventures founded

[17] Although most variables loaded high on their respective *a priori* defined factors, some loadings were moderately low (.33 - .39). Given the well-established nature of or measure, we included all items in our analyses. We also performed a number of robustness checks using only items with loadings above .40, which did not significantly alter our results (results are available upon request).

during the financial crisis period (which was most prominently felt in Belgium throughout 2008 until the middle of 2009) and 0 for all ventures founded before or after the crisis.

Product or service to be commercialized. Developing and commercializing a product, as opposed to delivering services, may require a larger set of capabilities and coordination. We therefore expect product-based start-ups to be founded by teams, particularly with an elaborate founding team structure. We include a dummy variable with the value 1 if the new venture is created around a product (including ventures that capitalize on both product and services) and 0 for those that do not involve product development.

University spin-off. Prior research shows that more than other firms, university spin-offs are more frequently founded by teams as opposed to a single entrepreneur (Colombo & Piva, 2012; Mustar & Wright, 2010). While on average these teams tend to be larger than the teams of their independent counterparts, research shows that their functional structure is usually constrained as their management teams are typically comprised of scientists and engineers with no, or little, commercial experience (Colombo & Piva, 2012). Therefore, we have a strong reason to suggest that starting up as a university spin-off has an effect on founding with a team, but not on the teams' functional structure. Hence, this variable is the exclusion restriction variable, which is included in the first-step selection equation (new ventures' probability to start-up with a team), but not in the second-step model (predicting elaborate structure of the team). We use a dummy variable for university spin-offs (1= university spin-off; 0 = otherwise) in the first stage.

Lead founder's prior commercial experience. To control for lead founders' human capital that may affect their propensity to start up with a team, we assess lead founders' prior commercial experience. Individuals with the high human capital relevant to their business may rely more heavily on their own capabilities and be less inclined to share responsibility over their venture. We therefore propose that, due to their higher self-reliance and the ability to mobilize external resources, lead founders' prior commercial experience is likely to negatively

affect starting up with a team (selection model), yet it is unlikely to affect the structural elaboration of the team. This variable is the exclusion restriction variable, which is included in the first-step selection equation (probability of starting up with a team), but not in the second-step model (predicting elaborate structure of the team). We define commercial experience in terms of how many years of work experience in business-related functions the lead founder had in the same sector as the start-up, before the founding of the new firm. This information was obtained through secondary data sources, such as web search, the company's websites, and LinkedIn.

Inverse Mill's ratio (IMR). The IMR are generated using the residuals (error term) from the selection model. In our study, the value of the IMR for each firm represents the predicted probability that they started up with a team, as opposed to being a lone entrepreneur. It needs to be noted that as a function, the IMR comprises both observed (i.e., measured) and unobserved (i.e., unmeasured) variables – that are captured through the error term (residual) in the selection equation and included to estimate the IMR through a non-linear function. As a result, including the IMR into the second-step outcome equation introduces a term that attempts to capture both observed and unobserved variables that affect selection.

4.4. Results

Tables 4.2 and 4.3 contain summary statistics and bivariate correlations for each of the sub-samples. The correlations between the variables are low to moderate. The overall sample of firms used in the first stage has the highest correlation (r = .28) between emotional stability and agreeableness. In the sub-sample of firms founded by teams (step two), the highest correlation between unrelated variables is between the inverse Mill's ratio (IMR) and emotional stability (r = - .59). The roles and the breadth of experience of the founding team are highly correlated with the elaborate structure variable because they are part of this measure.

Table 4.2. Descriptive statistics: First stage.

Full sample of firms (N = 148)

Variable	Mean	Std. Dev.	Min	Max
1. Team/ solo	.67	.47	0	1
2. FT size	2.15	1.14	1	7
3. University spin-off	.24	.43	0	1
4. Product	.74	.44	0	1
5. LF commercial experience	3.60	5.46	0	25
6. Conscientiousness	5.14	.86	2.78	6.84
7. Extraversion	4.93	.98	2.75	7
8. Agreeableness	5.20	.77	2.11	7
9. Emotional stability	4.84	.88	2.23	6.75

N= 148

	1	2	3	4	5	6	7	8
1. Team/ solo	1.00							
2. University spin-off	.21	1.00						
3. Product	.05	-.05	1.00					
4. LF commercial experience	-.16	-.01	-.05	1.00				
5. Conscientiousness	.12	.18	-.04	.09	1.00			
6. Extravert	.05	-.03	-.01	.20	.09	1.00		
7. Agreeable	.14	-.05	-.01	.05	.20	.12	1.00	
8. Emotional stability	.19	.11	-.01	.01	.10	.27*	.28*	1.00

N= 148; *p<0.01

Table 4.3. Descriptive statistics: Second stage.

Sub-sample of firms founded by teams (N= 91)

Variable	Mean	Std. Dev.	Min	Max
1. FT elaborate structure	.36	.83	-1.37	2.77
2. FT role breadth	1.99	.81	1	4
3. FT experience breadth	1.99	.99	0	4
4. FT size (log)	.96	.32	.69	1.95
5. Product	.76	.43	0	1
6. IMR	.48	.24	.08	1.17
7. Conscientiousness	5.21	.89	2.78	6.84
8. Extraversion	4.96	1.01	2.75	6.75
9. Agreeableness	5.23	.72	3.67	6.69
10. Emotional stability	4.98	.91	2.23	6.75

N= 91

	1	2	3	4	5	6	7	8	9
1. FT elaborate structure	1.00								
2. FT role breadth	.77*	1.00							
3. FT experience breadth	.77*	.19	1.00						
4. FT size (log)	.35*	.33*	.21	1.00					
5. Product	.09	.09	.05	.08	1.00				
6. IMR	.16	.10	.14	-.01	-.07	1.00			
7. Conscientiousness	.16	.06	.19	-.09	-.13	-.26	1.00		
8. Extraversion	.04	-.03	.09	.08	.13	-.25	.09	1.00	
9. Agreeableness	.08	.10	.03	.16	-.13	-.39*	.15	.07	1.00
10.Emotional stability	.10	.13	.02	-.05	.03	-.59*	.12	.21	.34*

N=91; *p<0.01

Table 4.4 present the results of the probit model used in the first-step model to predict the likelihood of founding with a team as opposed to going solo. Model 1 is the baseline model that includes the main effects of our control variables. In line with prior research (e.g., Bonardo, Paleari, & Vismara, 2011; Mustar & Wright, 2010), university spin-offs are more likely to found with teams than with a lone entrepreneur. Commercial experience is negatively related to founding by team, suggesting that lead founders who are familiar with the market primarily rely on their own experience to fulfil organizational roles.

Table 4.4. Effects of personality traits on founding with a team as opposed to going solo

First stage model: Probit regression model with robust standard errors

Team vs. solo	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Founding year								
crisis	-.30	-.33	-.31	-.24	-.32	-.29	-.29	-.30
	(.25)	(.25)	(.25)	(.25)	(.25)	(.26)	(.26)	(.26)
University spinoff	.58**	.60**	.65**	.55*	.53*	.59**	.63**	.60**
	(.29)	(.29)	(.28)	(.29)	(.29)	(.29)	(.29)	(.29)
Product	.17	.20	.20	.18	.18	.21	.22	.22
	(.25)	(.25)	(.25)	(.25)	(.25)	(.25)	(.25)	(.25)
Commercial exp.	-.04*	-.05**	-.04**	-.04**	-.04**	-.05**	-.05**	-.05***
	(.02)	(.02)	(.02)	(.02)	(.02)	(.02)	(.02)	(.02)
Extraversion		.19*				.13		
		(.11)				(.12)		
Agreeableness			.24*			.15		
			(.15)			(.16)		
Emotional stability				.27**		.19		
				(.13)		(.14)		
Conscientiousness					.18	.11		.11
					(.12)	(.13)		(.13)
Interpersonal disposition							.50***	.47**
							(.19)	(.19)
_constant	.42	-.48	-.85	-.86	-.42	-2.47**	-2.07**	-2.48**
	(.24)	(.58)	(.81)	(.68)	(.68)	(1.13)	(.97)	(1.12)
Wald chi^2	8.60*	12.28**	12.79**	14.94***	12.07**	19.37**	18.42***	19.27***
Pseudo R^2	.06	.07	.08	.08	.07	.10	.10	.10
Log pseudo-likelihood	-88.30	-87.02	-86.91	-86.13	-87.48	-84.49	-84.86	-84.53

N= 148; *p <0.10; **p <0.05; ***p <0.01, two-tail test

Models 2 to 5 depict the main effects of the personality traits individually, and Model 6 shows the effects of these traits when entered simultaneously. Consistent with our expectations, extraversion ($p < 0.1$, two-tailed test), agreeableness ($p < 0.1$, two-tailed test) and emotional stability ($p < 0.05$, two-tailed test) are positively related to founding by team. To obtain a better understanding of how large and important these findings are, we calculated the marginal effects of a unit increase of each of these personality traits – using the Marginal Effects at Means (MEM) approach. This method allows us to calculate predicted probabilities for each of the individual based on their personality score, while setting all other variables equal to their mean. We plotted these predicted probabilities to create a visual representation of the marginal effects – the Average Adjusted Probabilities plots (See Appendix 4.6.1) – depicting the predicted probabilities for each personality type given that all other conditions are average. With all other conditions being average, an increase of one scale unit of extraversion translates into a 7% increase in probability of founding with a team. The same scale unit increase for agreeableness produces a 9% increase, and for emotional stability, a 9% increase. From the plots we can also see that a highly extravert lead founder (extraversion=7) is 40% more likely to start-up with a team than a highly introvert (extraversion=1) individual, while a highly agreeable (agreeableness=7) lead founder is 50% more likely to start-up with a team than a highly disagreeable (agreeableness=1) individual, and a highly emotionally stable (emotional stability=7) lead founder is almost 60% more likely to start-up with a team than a highly instable (emotional stability=1) individual. This provides support for our hypotheses 1(a-c), which state that personality traits associated with interpersonal intelligence (extraversion, agreeableness and emotional stability) play a role in setting up a business by a team.

Model 6 includes all three personality traits in order to test for the independent effects of these variables. However, all three are insignificant in this model, and this may be ascribed to the fact that they are correlated. This is consistent with our theoretical arguments suggesting that extraversion, agreeableness and emotional stability reflect personality traits displaying

interpersonal disposition – and could therefore be considered as components of one construct. We therefore create an index variable representing the interpersonal disposition by using the mean of the three standardized variables and examine its effects on founding with a team (Model 7 & 8). In line with our expectations, interpersonal disposition is significantly positively related to founding with a team ($p < 0.01$ in Model 7 and $p < 0.05$ in Model 8, two-tailed test). We also find that consistent with our expectations, conscientiousness is not significantly related to founding with a team. This provides further support to our argument that deliberation and planning may play an important role for structuring but not for the interpersonal aspect of team formation.

Table 4.5 present the results of the OLS model used in the second stage to predict founding team structure. The large and significant coefficients of the inverse Mill's ratio indicate that there is a selection effect (elaborate team structure is conditional on founding by team), hence the use of a selection model is appropriate. Model 1 is our baseline model that shows the effects of our control variables. Founding team size is significantly related to founding team elaborate structure, as the more team members there are, the more likely it is to cover all the necessary functional roles and experience. Model 2 depicts the effects of our key independent variable – conscientiousness. Consistent with our expectation, conscientiousness is positively related to the founding team's elaborate structure ($p < 0.05$, two-tailed test). Our marginal effect analysis suggests that one scale unit increase of conscientiousness translates into 17% increase in the elaborateness of the founding team structure. This provides support to our hypothesis 2, which states that conscientiousness as a personality trait that relates to deliberation, planning and organization has a positive effect on the elaboration of founding team structure. Models 3-6 show interaction effects of conscientiousness and other personality traits. The interaction effects between conscientiousness and extraversion and between conscientiousness and agreeableness are non-significant, thus showing no support for our

hypotheses 3a and 3b. Interaction between conscientiousness and emotional stability is positive and significant ($p < 0.1$ ($p = 0.056$), two-tailed test), providing support for our hypothesis 3c.

Table 4.5. Effects of personality traits on elaborate founding team structure

Second stage model: OLS regression model with robust standard errors & Inverse Mill's Ratios

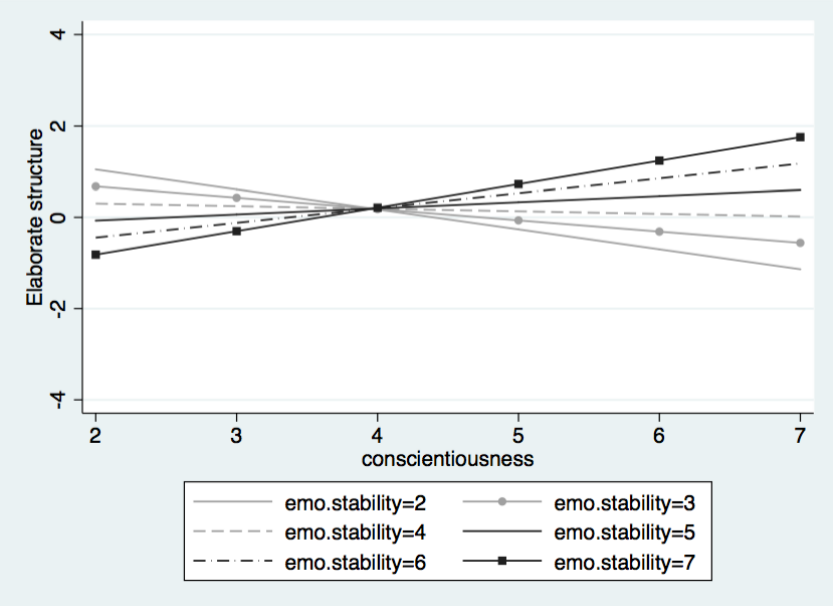
FT elaborate struct.	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Founding year						
crisis	.08	.00	-.01	-.00	.04	-.00
	(.20)	(.19)	(.19)	(.20)	(.20)	(.20)
Product	.23	.28	.27	.31*	.36**	.38**
	(.19)	(.18)	(.19)	(.18)	(.17)	(.18)
FT size (log)	1.00****	1.01****	1.01****	.95****	.91****	.86***
	(.23)	(.24)	(.24)	(.26)	(.26)	(.27)
IMR	.55	.76**	.75**	.93***	1.25***	1.40****
	(.35)	(.34)	(.35)	(.35)	(.38)	(.40)
Conscientiousness		.17*	-.10	.42	-.81	-.18
		(.09)	(.43)	(.57)	(.55)	(.77)
Extraversion			-.26			-.21
			(.41)			(.34)
Consc. X extravers			.05			.04
			(.08)			(.06)
Agreeable				.42		.86
				(.57)		(.58)
Consc. X agreeable.				.39		-.15
				(.53)		(.12)
Emotional stability					-.77	-.71
					(.48)	(.50)
Consc. X emo stab					.19*	.19*
					(.10)	(.10)
_constant	-1.05****	-2.10****	-.73	-4.16	1.65	-2.16
	(.31)	(.62)	(2.24)	(2.84)	(2.76)	3.96
Model F	6.04*****	5.23*****	3.64***	4.61*****	6.83*****	5.15*****
R 2	.20	.23	.23	.24	.29	.31
Root MSE	.76	.75	.75	.75	.72	.73

N= 91; *p<0.10; **p <0.05; ***p <0.01, two-tail test

To illustrate the effect of this interaction, we present a figure (Figure 4.2) showing the marginal impact of conscientiousness and emotional stability on the founding team's elaborate structure, based on the estimates from Model 5. Consistently with our hypotheses, highly conscientious, emotionally stable lead founders form more elaborately structured teams. From the graph, we can see that conscientiousness alone does not drive founding team structure, as highly

conscientious but emotionally instable founders are less likely to form structurally elaborate teams. Furthermore, it seems that high conscientiousness may even have adverse effects in emotionally instable founders – which gives support to the notion that the combination of high conscientiousness and emotional instability is detrimental as it reflects individuals' inability to reach the high standards they set for themselves (Witt et al., 2004).

Figure 4.2. Interaction effects of conscientiousness and emotional stability on elaborate founding team structure



4.4.1. Robustness analyses

We performed a number of supplementary analyses with different variations of independent and dependent variables to verify the robustness of our results (See Appendix 4.6.2.). The results of our first-stage model are robust to operationalizing the dependent variable as team size, with extraversion, agreeableness and emotional stability significantly positively associated with founding team size and conscientiousness remaining insignificant.

To examine the robustness of the results in the second stage model, we performed sub-scale analyses, examining the effects of lead founder's personality on founding team's breadth of roles and on founding team's breadth of experience. Consistent with prior research, the majority of new ventures within our sample were started by teams with (a) limited roles breadth and (b) limited breadth of experience – causing the distribution of these two variables to be highly right-skewed. The use of the OLS regression is clearly inappropriate. We therefore performed a Poisson regression model – after having confirmed that our data does not suffer from over-dispersion (i.e., the assumption of equality of variance and mean of the dependent variable)[18].

In line with our results, we find conscientiousness significantly positively related to founding team's breadth of experience and the interaction of conscientiousness and emotional stability positively relates to founding team's breadth of roles. Due to the relatively low number of cases in our second stage model (N=91), we were trying to keep the number of control variables low in order to avoid overfitting the model. In our supplementary analyses, we ran it with a number of additional control variables, including various sector dummies (e.g., ICT, biotechnology, business & services), university spin-off, lead founder's prior commercial experience and prior start-up experience. The results remain robust throughout the models. In

[18] The preference of the *Poisson* model is confirmed by an unreported likelihood ratio test of the over-dispersion parameter alpha, showing the alpha coefficient (the over-dispersion parameter) is not significantly different from zero (thus confirming the null hypothesis that Poisson is the preferred model).

summary, these supplementary analyses indicate that our findings are generally robust across various model specifications and variable operationalizations.

4.5. Discussion

The goal of this study was to examine the micro-foundations of organizational blueprints, by focusing on the role of the lead founder's personality. Our main findings are that the leader's personality matters for the initial decision to form a team, as well as for the way the team is organized. Personality traits that reflect interpersonal disposition (extraversion, agreeableness, emotional stability) predict team-based founding, as opposed to being a solo-entrepreneur. Personality traits associated with diligence and planning (conscientiousness) are positively related to elaborate founding team structure. Remarkably, conscientiousness was found to be unrelated to founding with a team, while personality traits associated with interpersonal disposition were not related to founding team elaborate structure. However, these traits may interact to predict elaborate founding team structure.

These findings make several contributions to the theories about entrepreneurial firms. First, this study aims to contribute to the research on founding conditions – by investigating the origins of the founding team structures. A large number of studies have researched the long-lasting effects of early organizational structures, suggesting that they are difficult to change even when all founders have left the organization (Baron & Hannan, 2002; Beckman & Burton, 2008; Leung et al., 2013). While focusing on the consequences of early organizational structures, only a few studies have examined their origins, leaving the important question of why a diversity of structural design exists in new ventures. The most comprehensive account of the mechanisms governing founding team formation was provided by the seminal paper of Ruef and colleagues (2003). This study provides a thorough examination of various sociological influences on the team design of new ventures'– including homophily, functionality, status expectations, network and ecological constraints (Ruef et al., 2003). While

the authors acknowledge the important role of the lead founder and their decision to involve others in the entrepreneurial process, to date, the role of this individual has not been well understood. We aim to contribute to this line of work by taking a psychological approach to team formation and focusing on the individual lead founder. To our knowledge, the present study is the first attempt to elucidate the role of the individual lead entrepreneur in the team formation process. We provide a set of theoretical and empirical arguments that the early organizational choices can be traced to the very dispositional traits of the lead entrepreneur as a key decision maker.

While controlling for a number of environmental, organizational and individual characteristics, we found that the lead founders' personality is reflected in their propensity (1) to start-up with a team as opposed to being a solo entrepreneur, and conditionally on this decision (2) to start up with a structurally elaborate founding team. The early work suggesting that the personality of founders matters in setting an organizational blueprint is the qualitative study by Kimberly (1979) that examined the birth and development of a new school of medical education. The author showed that the founder's personality, along with other characteristics, had a long-lasting effect on a number of subsequent organizational outcomes. In the present study, we examine quantitatively the role of the personality of the lead founders in the creation of the early structures of new ventures. Focusing on the micro-foundations of organizational blueprint, we also aim to address recent calls for more micro-level theories and explanations of imprinting and the origins thereof (Simsek et al., 2015, p.20; Nikiforou et al., 2018).

Second, this study contributes to the research on personality in entrepreneurship. Although personality, as measured by the Big Five, has been frequently linked to new venture performance (e.g., Barrick & Mount, 1991; Zhao & Seibert, 2006; Zhao et al., 2010), the results have remained mixed and inconclusive. This has been partially ascribed to the distal nature of entrepreneurial performance outcomes that has led to a new wave of calls for more research on intermediate outcomes between personality and new venture performance. As personality

reflects disposition and not determination, it is likely to predict only broad behaviours (Epstein & O'Brien, 1985), including tendencies to shared responsibility, sociability, compromise, organizing, and planning. We therefore focus on the more proximal outcome and examine the effects of lead founders' personality traits on the choice of an important start-up mode – founding team structure. We show how the personality of lead founders may reflect a preference towards a collective (team-based) start-up mode. We also show how conscientiousness may affect lead founders' choice of a more elaborate founding team. Both of these start-up modes have been considered important for new venture success. Hence, focusing on the effects of personality on these start-up modes may shed more light onto the effects of personality in entrepreneurial process.

Furthermore, examining the effects of conscientiousness, we build our argumentation around diligence and planning as a facet of conscientiousness. We hypothesized and showed empirically that, through organization and planning, conscientiousness is positively associated with founding with an elaborate team, which in turn is likely to affect new the venture's long-term success. This is particularly intriguing because the traditional entrepreneurship research examined the effects of conscientiousness by predominantly focusing on the mechanisms related to the need for achievement but ignoring the diligence facet altogether. In the present study we show that diligence facet of conscientiousness also matters as it is likely to lead to a more successful blueprint for an organization. We therefore propose a more modest view of an entrepreneur, suggesting that being a thorough organizer and planner is a quality that can lead to a successful nascent organization.

Beyond informing the literature on entrepreneurship, these findings contribute to the research on upper echelons, by focusing on the degree to which founding team structure reflects both a clear distribution of functional tasks and a broad set of experience that would enable individuals to successfully complete these tasks. We proposed the concept of "elaborate structure" to describe teams that comprise both of these features. Capturing the two important

attributes of a team in one overarching construct allows for a better understanding of the antecedents and the simultaneous effects of both.

4.5.1. Limitations

As with any other study, this work is not without limitations. Like most studies in entrepreneurship, the present work was challenged by the difficulty of data collection, as a result of which the data for founders and new ventures may be somewhat incomplete. With regard to founders, we have recorded a large amount of career history data for each individual within the founding team, but not all of the prior experiences could be retrieved. For instance, we don't have a detailed account of the lead founder's prior working experience with regard to organizational design. In light of imprinting arguments, it would be reasonable to examine whether lead founders are likely to structure their organizations based on their familiarity with certain designs. With regard to new ventures, one of the limitations is that we do not have the kind of detailed performance accounts that are available for established public firms. As small and medium enterprises are not legally obliged to make their data public, this is a difficulty common to the entrepreneurship field in general.

Although the main strength of this study is the unique longitudinal dataset of technology-based new ventures, which we traced throughout a longer period of time after their legal founding and thus did not limit our sample to success stories only, one variable was assessed retrospectively. To assess lead founders' personality, we relied on a questionnaire that was sent out to new ventures after their legal incorporation. We did so basing our reasoning on the notion of stability of personality traits that is widely accepted within the personality research field (Costa & McCrae, 1988; Roberts, Wood, & Caspi, 2008; Srivastava, John, Gosling, & Potter, 2003). While it has been acknowledged that personality traits may change as individuals age (Roberts, Walton, & Viechtbauer, 2006; Scollon & Diener, 2006; Soto, John, Gosling, & Potter, 2011), these changes tend to be relatively small and invariant across

different age groups with the majority of individuals experiencing changes of no more than half a point in either direction (Cobb-Clark & Schurer, 2012). Therefore, personality traits continue to be seen as stable patterns that distinguish individuals from others (Bleidorn, Kandler, Riemann, Angleitner, & Spinath, 2009; Roberts, Wood, & Caspi, 2008).

Another limitation of this study is related to the unobserved heterogeneity. Although we performed a number of supplementary analyses to rule out the various potential influences to the extent possible, future research should try to isolate the effects of a lead founder's personality by focusing on one single industry and type of venture. This may allow for better control over the environmental and organization-related influences.

4.6. Appendix to Chapter 4

Appendix 4.6.1. Marginal effects

Figure 4.3. Marginal effects of extraversion on founding with a team

Figure 4.4. Marginal effects of agreeableness on founding with a team

Figure 4.5. Marginal effects of emotional stability on founding with a team

Figure 4.6. Marginal effects of conscientiousness on elaborate founding team structure

Figure 4.3. Marginal effects of extraversion on founding with a team

Average adjusted predictions (AAP)[19] and confidence interval at each representative value of extraversion

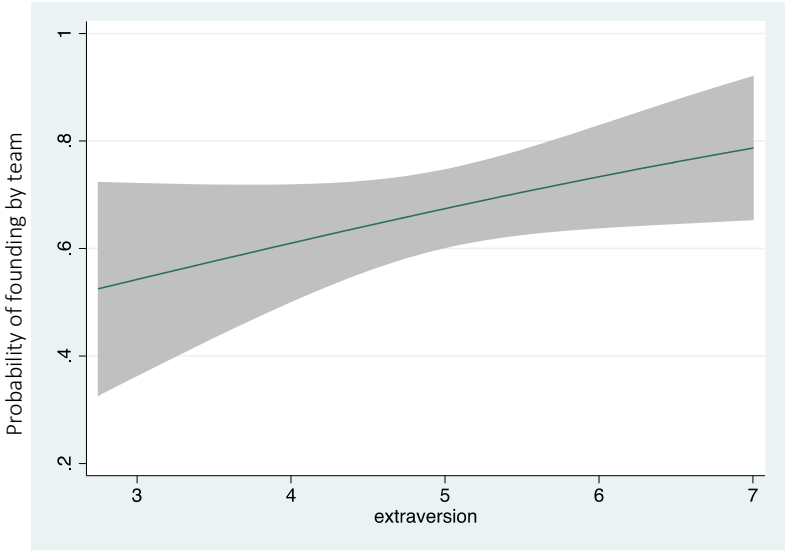


Figure 4.4. Marginal effects of agreeableness on founding with a team

Average adjusted predictions and confidence interval at each representative value of agreeableness

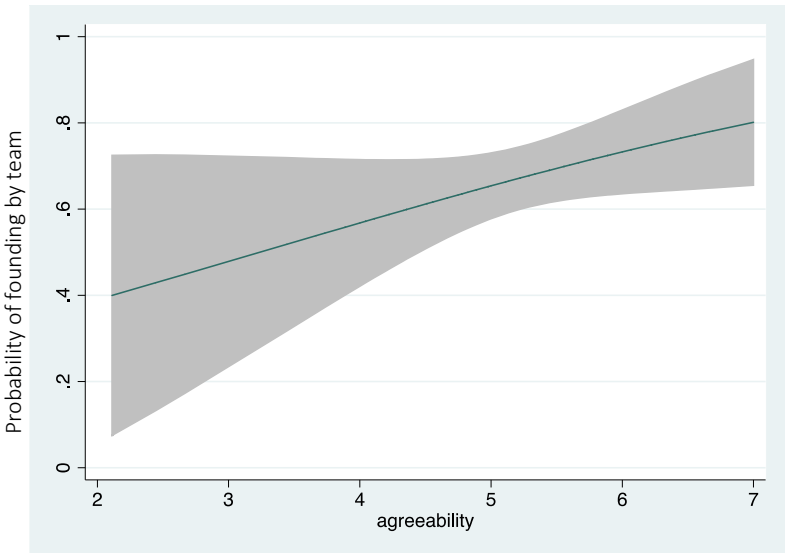


Figure 4.5. Marginal effects of emotional stability on founding with a team

[19] Patrick Royston's marginscontplot command was introduced in 2013 to address the limitations of the margins and marginsplot commands in STATA 11 and 12, which focus primarily on categorical variables, while continuous predictors were rather neglected. Marginscontplot command facilitates visualization of the marginal effect of a continuous
predictor in a meaningful way for a wide range of regression models, including OLS, general linear models, logit, probit, Poisson, and Cox proportional hazard model.

Average adjusted predictions and confidence interval at each representative value of emotional stability

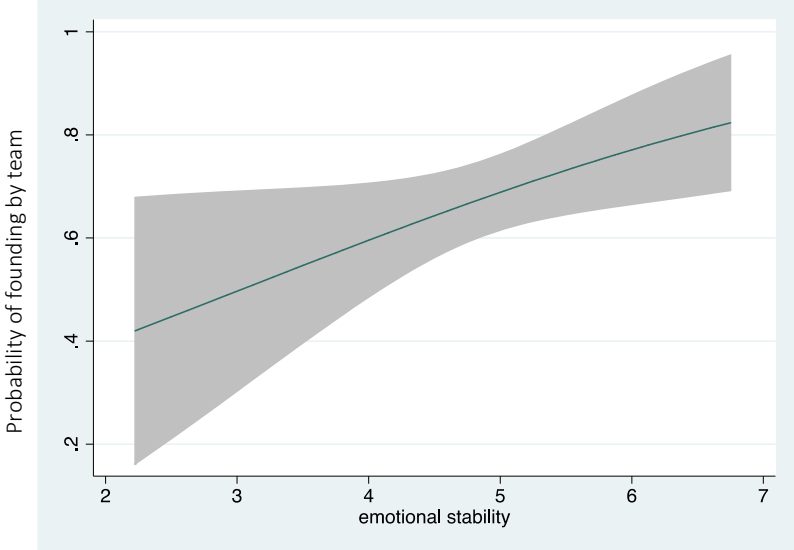
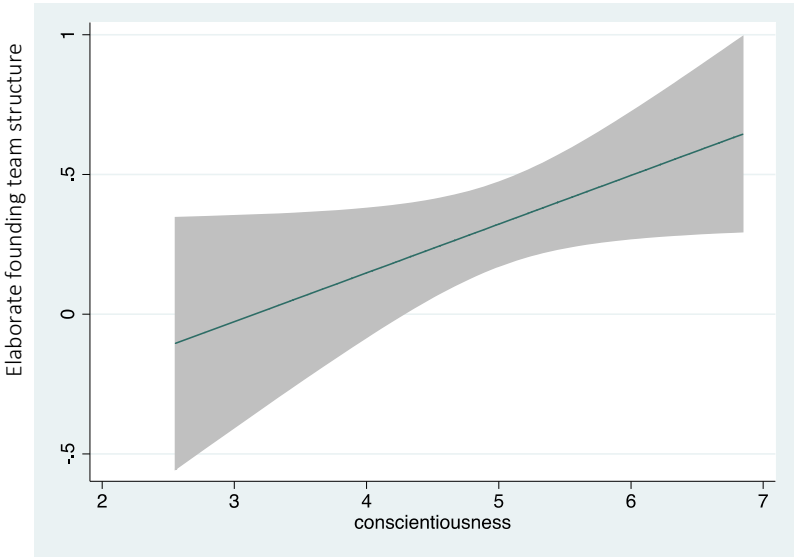


Figure 4.6. Marginal effects of conscientiousness on elaborate founding team structure

Average adjusted predictions and confidence interval at each representative value of conscientiousness



Appendix 4.6.2. Additional analyses

Table 4.6. Effects of personality traits on founding team size

Table 4.7. Effects of personality traits on founding team roles breadth

Table 4.8. Effects of personality traits on founding team breadth of experience

Table 4.6. Effects of personality traits on founding team size

First stage model: Poisson regression model with robust standard errors

Team vs. solo	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Founding year						
crisis	-.021	-.036	-.017	.002	-.024	-.018
	(.10)	(.10)	(.10)	(.10)	(.10)	(.10)
University spinoff	.188**	.191**	.209**	.168*	.176*	.195**
	(.09)	(.09)	(.09)	(.09)	(.09)	(.08)
Product	.081	.086	.096	.087	.085	.098
	(.09)	(.09)	(.09)	(.09)	(.09)	(.09)
Commercial exp.	-.008	-.011	-.010	-.009	-.009	-.011
	(.01)	(.01)	(.01)	(.01)	(.01)	(.01)
Extraversion		.091**				.068*
		(.23)				(.04)
Agreeableness			.141***			.114**
			(.05)			(.05)
Emotional stability				.240*		.043
				(.28)		(.05)
Conscientiousness					.036	.002
					(.05)	(.04)
_constant	.689****	.249	-.061	.240	.506*	-.473
	(.09)	(.23)	(.30)	(.28)	(.27)	(.43)
Wald chi^2	5.71	10.188*	11.87**	9.52**	5.97	15.45*
DF	4	5	5	5	5	8
Pseudo R^2	.007	.013	.015	.0115	.0079	.0196
Log pseudo-likelihood	-229.389	-228.200	-227.575	-228.402	-229.246	-226.546

N= 148

*p<0.10; **p<0.05; ***p<0.01, two-tail test

Table 4.7. Effects of personality traits on founding team roles breadth

Second stage model: Poisson regression model with robust standard errors & Inverse Mill's Ratios

FT roles breadth	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Founding year						
crisis	.019	.015	.028	.015	.024	.028
	(.09)	(.09)	(.09)	(.09)	(.10)	(.09)
Product	.095	.097	.103	.102	.141	.151
	(.11)	(.11)	(.10)	(.11)	(.10)	(.10)
FT size (log)	.443****	.444****	.462****	.434****	.395****	.418****
	(.10)	(.10)	(.11)	(.11)	(.11)	(.12)
IMR	.181	.191	.131	.215	.359**	.348*
	(.17)	(.16)	(.18)	(.18)	(.19)	(.20)
Conscientiousness		.009	-.052	.030	-.501*	-.220
		(.05)	(.27)	(.33)	(.28)	(.35)
Extraversion			-.115			-.087
			(.23)			(.19)
Consc. X extravers			.013			.005
			(.05)			(.04)
Agreeable				.041		.295
				(.33)		(.24)
Consc. X agreeable.				-.004		-.058
				(.06)		(.05)
Emotional stability					-.421*	-.404*
					(.24)	(.23)
Consc. X emo stab					.099*	.100**
					(.05)	(.05)
_constant	.087	.033	.598	-.186	2.152	.873
	(.16)	(.29)	(1.25)	(1.76)	(1.35)	(1.79)
Wald chi^2	23.75*****	23.67*****	26.37*****	25.51*****	44.38*****	58.19*****
DF	4	5	7	7	7	11
Pseudo R^2	.0179	.0179	.0196	.0180	.0240	.0267
Log pseudo-likelihood	-127.993	-127.988	-127.774	-127.974	-127.196	-126.845

N= 91

*p<0.10; **p<0.05; ***p<0.01, two-tail test

Table 4.8. Effects of personality traits on founding team breadth of experience

Second stage model: Poisson regression model with robust standard errors & Inverse Mill's Ratios

FT exper. breadth	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Founding year crisis	.048	-.026	-.056	-.037	-.014	-.064
	(.12)	(.11)	(.11)	(.12)	(.11)	(.12)
Product	.107	.142	.124	.169	.170	.177
	(.14)	(.13)	(.13)	(.13)	(.13)	(.13)
FT size (log)	.331**	.356***	.333**	.304**	.316**	.260*
	(.14)	(.14)	(.13)	(.14)	(.14)	(.14)
IMR	.270	.444**	.500**	.575***	.602***	.742****
	(.22)	(.20)	(.20)	(.22)	(.21)	(.51)
Conscientiousness		.154***	-.027	.486	-.181	-.109
		(.06)	(.25)	(.37)	(.36)	(.51)
Extraversion			-.111			-.131
			(.26)			(.24)
Consc. X extravers			.034			.035
			(.05)			(.04)
Agreeable				.444		.552
				(.37)		(.39)
Consc. X agreeable.				-.063		-.087
				(.07)		(.07)
Emotional stability					-.254	-.248
					(.34)	(.35)
Consc. X emo stab					.065	.062
					(.07)	(.07)
_constant	.140	-.785**	-.149	-3.151	.478	-1.777
	(.22)	(.35)	(1.35)	(2.02)	(1.84)	(2.71)
Wald chi^2	8.77*	23.13****	26.27****	28.61*****	34.17*****	42.94*****
DF	4	5	7	7	7	11
Pseudo R^2	.0133	.0235	.0267	.0270	.0273	.033
Log pseudo-likelihood	-134.416	-133.021	-132.588	-132.540	-132.507	-131.729

N= 91

*p<0.10; **p<0.05; ***p<0.01, two-tail test

Appendix 4.6.3. Factor analysis of the Big Five Inventory of personality traits

Table 4.9. Factor analysis of the five-factor model (Big Five) of personality traits

Table 4.9. Factor analysis of the five-factor model (Big Five) of personality traits

Factor analysis/correlation (N=169), Rotation: oblique promax (Kaiser off)

Variable	Factor1	Factor2	Factor3	Factor4	Factor5	Uniqueness
extravers1		0.7503				0.4185
extravers2		0.6549				0.5805
extravers3	0.4213	0.3418				0.6063
extravers4	0.3996	0.3405				0.5510
extravers5		0.7891				0.4152
extravers6		0.5640				0.5864
extravers7		0.6878				0.5282
extravers8		0.6500				0.4787
agreebl1					0.5298	0.6543
agreebl2					0.4913	0.6447
agreebl3					0.5305	0.6388
agreebl4					0.4665	0.6810
agreebl5					0.3777	0.7221
agreebl6		0.3598			0.4929	0.6065
agreebl7					0.5355	0.6047
agreebl8					0.6298	0.6066
agreebl9					0.4060	0.6585
conscient1			0.7707			0.4180
conscient2			0.4652			0.7659
conscient3			0.6563			0.5231
conscient4			0.5204			0.6134
conscient5			0.3819			0.7322
conscient6			0.5652			0.5446
conscient7			0.4501			0.7221
conscient8			0.5415			0.6866
conscient9			0.4989			0.6763
openess1	0.6961					0.5136
openess2	0.6052					0.6019
openess3	0.5446					0.5779
openess4	0.5953					0.5856
openess5	0.7784					0.3719
openess6	0.4346					0.6649
openess7	0.3405					0.8474
openess8	0.6536					0.5019
openess9†						0.8527
openess10†						0.8589
neurotic1[20]				0.3111		0.6625
neurotic2				0.7885		0.4035
neurotic3	0.3664			0.3787		0.6158
neurotic4				0.4875		0.6673
neurotic5				0.6497		0.5162
neurotic6				0.3542	-0.4383	0.5506
neurotic7				0.7549		0.3751
neurotic8				0.7205		0.5125

† Correlations below .30 are suppressed

[20] Emotional stability measure is a reverse scale of the questionnaire's original neuroticism items

CHAPTER 5: EXPANDING THE CIRCLE: ANTECEDENTS OF A NEW MANAGERIAL HIRE IN TECHNOLOGY-BASED NEW VENTURES

Abstract

As new ventures evolve, founders become less adept at managing their firms beyond their initial focus, yielding to a need to readjust the team. Building on the life-cycle perspective, we examine an important yet understudied milestone in the development of a new venture – its first manager-level hire. In a unique sample of 634 yearly organizational observations (2006 – 2010) of 148 Flemish technology-based start-ups, we find that the strength of the need to hire a new manager is determined by multi-level forces – related to the founding teams' human capital, board characteristics and new ventures' environment. We examine the relative effects of each of these characteristics and discuss the role of the environmental fit of team and board characteristics.

Key words: board, environment, founding team, life cycle of a firm, new managerial hire

5.1. Introduction

New ventures are typically founded by a group of friends or colleagues (Klotz, Hmieleski, Bradley, & Busenitz, 2014; Ruef, Aldrich & Carter, 2003) whose knowledge, skills and charisma are the major source of new firms' initial human capital (Beckman & Burton, 2008; Boeker & Wiltbank, 2005; Eisenhardt & Schoonhoven, 1990). However, over the course of time, as the venture develops, a new set of managerial and operational demands evolve, outgrowing the capabilities of initial founders. In response to this growing mismatch, new firms need to readjust their team by hiring new professionals (Boeker & Karichalil, 2002; Hellmann & Puri, 2002; Quinn & Cameron, 1983). This first manager-level hire is an important milestone in a life of a new venture as it sets the course towards transition from a small, typically

unstructured venture managed by a rather informal entrepreneurial group to a fully developed organization led by a professional management team. New hires are considered to increase the managerial capability of a developing firm contributing to its overall development and long-term growth (Eisenhardt & Schoonhoven, 1990; Gilbert, McDougall, & Audretsch, 2006; Wasserman, 2017).

Despite the importance of the first managerial hire in the life of a start-up, we know surprisingly little about when firms are likely to reach this milestone and what factors influence its completion. Prior research has shown that new ventures adjust their teams in response to a significantly high or exceptionally low firm growth (Boeker & Karichalil, 2002). Yet studies also show that even under the extreme levels of either growth or decline, ventures differ with respect to their likelihood to augment the team. These differences were typically ascribed to teams' human capital (e.g., Boeker & Wiltbank, 2005; Ferguson, Cohen, Burton, & Beckman, 2016; Ucbasaran, Lockett, Wright, & Westhead, 2003), as well as to organizational characteristics related to board oversight (Boeker & Wiltbank, 2005; Wasserman, 2003). While these studies generated a number of valuable insights on either the team or firm-related attributes, they have not examined their conjoint effects and relative importance. The purpose of this paper is to integrate existing findings, as well as to extend them by offering new insights into what motivates professionalization of founding teams. We do so with a specific focus on growth-oriented technology-based start-ups, as these ventures are typically started by teams in which capability development proves particularly important (Gruber, MacMillan, & Thompson, 2008; Mustar & Wright, 2010). Following the life-cycle perspective (Greiner, 1972), we suggest that with the passage of time growth-oriented technology-based new ventures are faced with the need to update the competencies of their management teams[21].

[21] In line with prior research (e.g., Beckamn & Bruton, 2008), we use a more inclusive definition of a team, which also comprises solo entrepreneurs, due to their capacity to form a team by hiring a new manager.

Their likelihood to accommodate this need by hiring a new manager, however may depend on the attributes of the team, firm and its environment.

With regard to the team, we propose that two types of human capital play a pertinent role in new managerial hires: (1) one that reflects shortage of skills and (2) one that highlights founders' capacity to implement change. Prior work has predominantly focused on the former type, suggesting that new member additions are driven by the aim to fill existing gaps in teams' human capital important to pursue new ventures' goals and strategies (e.g., Chandler, Honig, & Wiklund 2005; Ucbasaran et al., 2003). In addition to reflecting a shortage of requisite skills, however, founding teams' human capital may also reflect teams' capacity to implement change. While it is common to think of a new venture as agile and highly responsive to contextual cues, founders' vision and consequently their decision-making may be constrained by their prior experience (Gruber, 2010; Gruber, MacMillan, & Thompson, 2013), but also by the aim to maintain full control over their venture (Adizes,1999; Boeker & Karichalil, 2002; Wasserman, 2013; 2017).

With regard to the organizational characteristics, we propose that external stakeholders apply pressures on new ventures to update capabilities of their team. We build on prior research which has unveiled the importance of board oversight and governance in initiating compositional change but did not distinguish between new member entries and founder exits (e.g., Boeker & Wiltbank, 2005). Because the two events are motivated by different mechanisms – whereby new member additions are strategic in their nature and founder exits are typically motivated by conflict within the team (Forbes, Borchert, Zellmer-Bruhn, & Sapienza, 2006; Vanaelst et al., 2006) – they should be studied independently. We examine the role of boards in new ventures' propensity to add a new manager to the team.

Changes to the team may also be triggered by new venture's environmental characteristics, as industry environments pose distinct technical and managerial requirements to the team and determine what competences teams need to develop to successfully manage

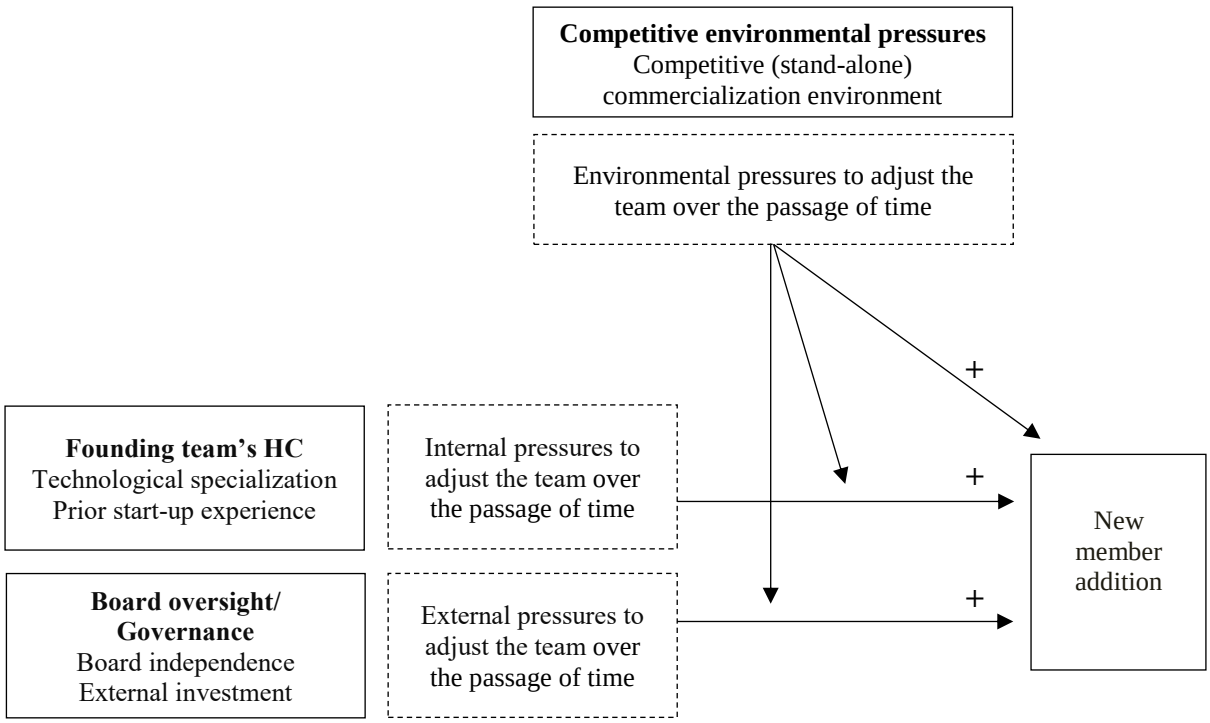
their firms (Eesley, Hsu & Roberts, 2014). To date, the role of the external environment in the evolution of a management team has been largely ignored, with the majority of studies merely controlling for the sector. We go beyond this approach and argue that the environmental commonalities across different sectors determine to a large extent what capabilities new ventures need and how these needs can be met over time. We focus on new ventures' commercialization environment, as the most salient environmental characteristics reflecting firms' commercialization strategies (Eesley et al., 2014). We further propose that the importance of team (human capital) and organizational (board oversight) characteristics is strengthened by the type of commercialization environment new ventures operate in. To examine this environmental fit, we build on the early contingency literature insights highlighting the impact of environment on firms' organizational design and evolution (Woodward, 1965). Figure 1 depicts our research model.

Our study was designed to make several contributions to the extant literature. First, we integrate findings generated by prior studies, which focused on different aspects of new ventures' compositional change, into one theoretical framework with a specific focus on the first new managerial addition. This approach allows us to evaluate the unique contribution of each of these variables. Second, we aim to contribute to the existing work, which has largely ignored the role of environment in teams' turnover, by examining the effects of environmental pressures on the development of managerial capabilities in entrepreneurial teams. Focusing on new ventures' commercialization environments, we examine contextual features that extend beyond the dimension of environmental stability versus dynamism and provide a more elaborate account on how environmental features shape technical and managerial requirements of the team. Third, we consider the role of environmental fit of internal (team and organizational) characteristics in elevating the need to hire new managers. To date, this is the first study to examine the contingent role environment in the process of founding team professionalization. Finally, we contribute to the stream of research in entrepreneurship and

management that adopts multilevel approach (e.g., Baum & Locke, 2004; Baum et al., 2001; Hitt, Beamish, Jackson, & Mathieu, 2007) by examining the antecedents of a new managerial hire on team (founding team's human capital), organization (board oversight) and environment (commercialization environment) levels of analysis, as well as the effects of the environmental contingency thereof.

We test our hypotheses in a unique longitudinal data set of 148 technology-based new ventures founded between 2006 and 2010 in Flemish region of Belgium. We use event-history analysis technique to assess which new ventures are more likely to add new managers to their team. To do so, we examine four groups of variables assessing (1) founding teams' human capital, (2) board oversight and (3) environment, as well as the (4) alignment of the founding team and board characteristics with the new ventures' commercialization environment. We find that all three levels of analysis are related to new managerial hire and discuss their relative importance.

Figure 5.1. Research model



5.2. Theoretical development

The success of a new venture depends on the ability of its leaders to continue meeting new challenges as the business evolves. With the passage of time, skills related to managerial competences, ability to work under increasing administrative load, and extensive delegation in place of control become increasingly important (Boeker & Wiltbank, 2005; Lewis & Churchill, 1983). As founders may not be able nor willing to adjust their personal management styles in order to match the evolving needs of their venture (Gilmore, 2003; Hellmann & Puri, 2002), new managers are needed to reduce the misfit between founders' capabilities and changing organizational demands. However, not all new ventures face equal organizational demands to begin with, yielding to a heterogeneity with respect to the strength of the need to augment the team over the course of time. Prior research has examined antecedents of membership change from different angles. Thereby, most scholarly attention has been devoted to the human capital of the team, including industry experience (Boeker & Wiltbank, 2005), functional diversity (Ucbasaran, Lockett, Wright, & Westhead, 2003) and discrepancies between teams' functional roles and qualifications (Ferguson et al., 2016). Less attention has been devoted to the firm-level antecedents, such as board oversight (Boeker & Wiltbank, 2005) and acquisition of external funds (Wasserman, 2003). To date, only one study has considered the effects of external environment, focusing on environmental dynamism (Chandler et al., 2005). Table 1 provides an overview of the most prominent quantitative studies on new member additions to new venture teams, highlighting that the antecedents of team change may be traced to multiple levels of analysis. In order to integrate these fragmented insights, we examine antecedents of new managerial hire on all three levels of analysis – with the specific focus on founding teams' human capital, board oversight, and commercialization environment.

Table 5.1. Overview of most prominent quantitative studies on new member additions

Study	Sample	Outcome	Antecedents			Contingency	Findings	Shortcomings
			Team	Organization	Environment			
Boeker & Wiltbank, 2005	86 semi-conductor NVs, Silicon Valley	TMT change (sum of exits & entries)	Team industry experience; Functional diversity	High growth/ low growth; strategic diversification; TMT ownership; CEO ownership; Board independence; VC involvement	na (sample from the same industry)	na	Teams with high industry experience and diversity are less likely to change. Growth has an inverted u-shape relationship with TMT change. Board independence plays no role. TMT ownership negatively relates to change, while CEO ownership & VC involvement positively related to change.	Did not distinguish between entries and exits.
Brinckman & Hoegl, 2011	178 technology -based NVs, Germany	New entry	Initial teamwork (quality of interaction, support, cohesion etc.) capability; initial relational (social capital) capability	na	na	na	Relational capabilities lead to more new member additions. Teamwork capabilities lead to fewer additions.	Based on respondents' retrospection; possible reversed causality
Chandler et al., 2005	124 NVs (all possible sectors, incl. non-tech based) founded, US	New entry	Team size Team diversity (industry experience, educational level, educational curriculum, gender, race, political affiliation, and religious affiliation)	Firm stage of development	Environment: Environmental dynamism (measured by survey)	na	Industry dynamism, Initial team size, Education, industry tenure and functional diversity are positively related to additions	Cross-sectional study design; reliance on self-reports
Ferguson et al., 2016	167 high-tech NVs, Silicon Valley (SPEC dataset)	New entry	Mismatch between TMT roles and TMT qualifications	na	na	Firm stage of development (completion of VC acquisition and IPO)	Underqualified teams (too little experience for the existing roles) are more likely to hire new managers than overqualified (too much experience, too little roles). Underqualified teams are more likely to hire new managers if they achieved developmental milestones (VC/ IPO)	External validity and sample selection: Silicon Valley - high rates of obtaining VC and IPO
Ucbasaran et al., 2003	90 NVs (all sectors), UK	New entry	Founding team HC: team size, mean age, family firm, Founding team's functional diversity	na	na	na	Size of founding team is negatively related to team member entry.	Sample selection; low N

5.2.1. Founding teams' human capital

Founders' prior experience constitutes the most critical human capital of a new venture, affecting a number of organizational outcomes (e.g., Dencker & Gruber, 2015; Colombo & Grilli, 2010; Shane & Stuart, 2002). We propose that two distinct types of human capital are associated with new managerial hires in technology-based start-ups: (1) the type that reflects shortage of important market-related and managerial competences – as highlighted by founders' technological specialization, and (2) the type that reflects teams' capacity to implement change – as highlighted by team's prior start-up experience.

Technological specialists archetype describes teams that have strong experience in the technological domain, but lack marketing, sales and management know-how. Typically composed of engineers and scientists wishing to commercialize their invention, these teams need to develop their managerial capabilities over the course of time. Prior start-up experience refers to whether the team members have founded and led a new venture before founding the focal firm. Teams with prior start-up experience are more likely to have obtained special insight into the entrepreneurial process and knowledge about firm formation and management, which in turn may equip them with a higher responsiveness to arising opportunities and threats (Baron & Ensley, 2006; Gruber et al., 2008). Because prior start-up experience involves high degree of learning-by-doing, it entails valuable tacit knowledge that cannot be easily learned through other sources (Delmar & Shane, 2006; Gruber et al., 2008).

Technological specialization. Although the nature of the tasks and leadership requirements changes over time as new venture evolves, some entrepreneurial teams may be better than others at adapting to the new business demands and adjusting their management styles. For instance, founding teams with a wide variety of knowledge, particularly in business and management domains, should have greater knowledge pool that would allow them to cope with

changing environmental demands (Boeker & Wiltbank, 2005). In contrast, teams with low variety of experience have a limited knowledge base to draw from, consequently lacking the requisite skills necessary to manage the evolution of their organization (Cohen & Levinthal, 1990; Aldrich, 1999). While broadly experienced founding teams may rely on their own readily available skills, teams with limited variety of experience should strive to enhance the knowledge base by hiring new managers. In a study of 86 Silicon Valley's semiconductor start-ups founded between 1983 and 1995, Boeker and Wiltbank (2005) found a negative relationship between top management team diversity and membership change, suggesting that homogeneous teams are more likely to augment their team in response to experience shortage.

Although, founding team diversity has been linked to a variety of positive organizational outcomes (Beckman & Burton, 2008; Beckman, Burton & O'Reilly, 2007; Eisenhardt & Schoonhoven, 1990) and could generally help adjusting to new organizational needs, most new ventures, both in general and within the technology-based sectors in particular, are founded by individuals with similar experience (Klotz et al., 2014; Ruef et al., 2003). A large share of technology-based new firms is started and led by scientists and engineers with no or little market-related experience (Beckman & Burton, 2008; Colombo & Piva, 2012; Eesley et al., 2014). While these teams benefit from a strong technological focus that allows for a thorough understanding of the technology and its potential applications (Danneels, 2002; Gruber et al., 2013), we expect these teams to be less adept at long-term managing of a firm and expect them to be more likely to hire new managers with the relevant business and managerial know-how.

We choose to take an archetype approach (Greenwood, 1988; 1993) and focus on technological specialist teams – teams that are composed solely of individuals with high technological expertise and no commercial work experience, nor education in business and management domains – because prior literature has suggested that a large proportion of

technology-based new venture teams begin with a technical founding team, which they subsequently professionalize by adding new more seasoned managers (Audia & Rider, 2005; Eesley et al., 2014). Furthermore, this archetype represents a team composition of extreme homogeneity in which essential managerial and business-related capabilities are missing. We therefore believe that teams of this archetype will experience an exceptionally strong need to complement team's competences through new member addition.

Hypothesis 1. New ventures whose founding team is technologically specialized are more likely to hire new managers.

Prior start-up experience. As new venture's business requirements shift over time, founders may not always be aware of, nor be able to address the competence shortages of their team. They may develop resistance to change due to their unwillingness to give up equity and control over their venture (Adizes,1999; Boeker & Karichalil, 2002; Wasserman, 2013), but also due to a low perception of added value through a new hire (Brinckmann & Hoegl, 2011) and the general inability to respond to changing environmental cues. This resistance however may be overcome by founding team's pre-existing knowledge that allows for effective information-gathering and processing behaviours (Pelled, Eisenhardt, & Xin, 1999). Prior start-up experience may supply new firms with this specific (and to the large extent tacit) knowledge, which has been repeatedly found important for environmental scanning with regard to new venture's opportunity and threat recognition (e.g., Baron & Ensley, 2006; Gruber et al, 2008; McGrath & MacMillan, 2000).

Expert information-processing theory posits that through repeated experience in a particular area individuals develop refined and complex cognitive schemes, which allow them to more effectively process new information to arrive at more optimal judgements (Gagné &

Glaser, 1987). Teams whose members have had prior start-up experience are more aware of the common challenges related to establishing and managing a new venture (Gruber et al, 2008; McGrath & MacMillan, 2000) and are therefore susceptible to its changing needs. For instance, scholars in the effectuation literature show that prior experience leads to a wider range of heuristics which help entrepreneurs to make better decisions in uncertain, even unpredictable environments (Sarasvathy, 2001). Having gone through the process of managing a new venture throughout different stages of its development founders are more likely to develop a better susceptibility to a variety of cues to effectively detect when a compositional change is necessary. Therefore, we propose that through increased susceptibility to environmental cues founding teams with prior start-up experience are more attentive to the venture's changing business demands.

Furthermore, founders with prior start-up experience benefit from the readily available knowledge of how to build a customer base, how to acquire funding, and where to look for strategic advice (Gruber et al., 2008). During their prior start-up experience, they are likely to have developed social ties to other start-up founders, managers, mentors and investors who may supply the firm with the contacts of potential candidates. Therefore, we expect founders of new ventures with prior start-up experience to be more inclined to hire new managers.

Hypothesis 2. New ventures whose founding team has prior start-up experience are more likely to hire new managers.

5.2.2. Board oversight

Next to the founding team characteristics, boards may increase new venture's propensity to change. The primary role of the board is to provide oversight as well as to support new ventures' strategic decision-making, including functional role assignments, remuneration and

team composition (Boeker & Wiltbank, 2005; Lynall, Golden, & Hillman, 2003). From the governance point of view, founders-managers are seen as agents of the principals who do not always share the residual profits of the enterprise. Consequently, the interests of the founders with regards to the firm's vision, goals and resources may be substantially different from those of the external equity owners. For instance, founders may be primarily concerned with pursuing their initial vision and maintaining their own position within the firm (Wasserman, 2013; 2017). To address this agency problem, boards are the primary means of monitoring founder-owner relationships (Busenitz, Fiet, & Moesel, 2004; Oviatt, 1988; Walsh and Seward, 1990). They carefully scan environment and proactively initiate changes within the new ventures to address arising opportunities and changing business demands. We propose that the likelihood of a board to initiate new managerial hire will depend on (1) its decision power – as reflected by board independence and on (2) its active involvement – as it is typically the case with external investors, such as venture capitalists (Busenitz, Fiet, & Moesel, 2004; Rosenstein et al., 1993).

Board independence. Previous work on governance has distinguished between outside and inside board members. Boards with higher proportion of outside members are considered to have higher board independence. While the outside board members may carefully fulfil their monitoring role, inside board members (board members that are also full-time managers) are more involved in the firms' day-to-day operations and may be less independent in their decision-making (Boeker & Wiltbank, 2005; Boyd, 1994; Rediker & Seth, 1995). Scholars argue that inside directors may be less interested in giving up their equity and sharing control with new managers, especially those that come from outside the firm. Particularly as founders, inside board members are involved in new ventures early gestation and are likely to develop personal attachment to their venture, which may result in limited objectivity and divergence of

interests from those of the outside directors (Westphal & Zajac, 1995). Founders-directors may be more reluctant to welcome changes that may undermine their own role in the venture, particularly because of the fear of losing control over new venture's decision-making or being removed from the venture altogether.

We therefore expect new ventures with less independent boards to be less likely to implement compositional change in their team. Boards with greater board independence, in contrast, will be less reserved and more proactive at critical monitoring of new venture's performance and capabilities of its management team. Prior research found that ventures with higher board independence are more inclined to initiate change within new venture teams (Boeker & Wiltbank, 2005; Wasserman, 2003; 13). In line with these insights, we propose that new ventures with higher board independence will be more likely to hire new managers.

Hypothesis 3. New ventures with high board independence are more likely to hire new managers.

External investment. Entrepreneurship research and governance literature have highlighted the importance of external investors in exerting pressures towards team membership change (Boeker & Wiltbank, 2005; Hellman & Puri, 2002; Kaplan & Stromberg, 2001; Wasserman, 2003). External investors that are actively involved in the operation and development of new ventures are venture capitalists, business angels and investors from the industry. Next to providing financial backing, these investors tend to be actively involved in new ventures' strategic decision-making, oversee operations and provide legal advice (Gompers & Lerner 2001). They closely monitor capabilities of the venture, as embodied by the experiences of its team, and are ready to implement compositional changes (Boeker & Wiltbank, 2005; Bruton & Ahlstrom, 2003; Wasserman, 2003).

These changes often occur in spite of the team's wish to remain unchanged, as founders often prefer to keep their positions (Busenitz, Fiet, & Moesel, 2004; Wasserman, 2003). Yet, because new firms usually lack necessary financial resources to invest in product development and key facets of their business model, they have to rely on external investors for capital. In return for capital external investors receive equity that grants them power to enforce their decisions. From the external investor's perspective, investing into a particular new venture is fraught with a high level of uncertainty, as early-stage ventures rarely have substantial tangible assets that one could assess (Gompers & Lerner, 1999; Sahlman, Stevenson, Roberts, & Bhide, 1999). To reduce this uncertainty, next to evaluating the business idea and the trajectory of the targeted market, investors assess quality of the entrepreneurial team by closely observing its skills. Prior research has shown that external investors actively initiate changes in composition of new ventures' management teams by reassigning roles and bringing in new professionals (Boeker & Wiltbank, 2005; Bruton & Ahlstrom, 2003; Wasserman, 2003). Bringing in new managers to the team is often a pre-requisite to complete an investment deal.

Furthermore, because external investors are not involved in the day-to-day activities of a new venture, they are not subjected to inertia that may emerge within teams driving them towards resistance to change. They are therefore susceptible to a wider range of cues indicating the need to augment the team. While founders identify more strongly with the firm they created and may believe that they have all it takes to successfully lead their firm, external investors have less personal and relational ties to the initial team and are therefore less reserved about changing its composition if it is needed. This way, external investors are able to closely monitor the team and enforce new managerial hires due to arising shortage of competence. We therefore propose that external investors will apply pressures on teams to hire new managers.

Hypothesis 4. New ventures obtaining external investment are more likely to hire new managers.

5.2.3. Commercialization environment

Organization research has long emphasized the importance of the firm's environment in shaping organizational decisions and outcomes (Cockburn, Henderson, & Stern, 2000; Porter, 1991; Stinchcombe, 1965). A firm's environment is known to exert pressures on organizations to lean towards a particular type of organizational design (Roberts & Greenwood, 1997), strategy (Eesley et al., 2014), and practice (Cockburn et al., 2000). Consequently, it affects the set of capabilities needed for new ventures to successfully compete in the market and applies pressures on the initial team make-up if it does not comply with these needs. Examining environmental pressures on organizational choices, prior research predominantly focused on environmental stability versus dynamism (Simerly & Li, 2000), and uncertainty (Leifer & Huber, 1977) constructs. While useful for explaining a variety of organizational phenomena, this distinction does not offer a nuanced account of how new ventures' technological and managerial requirements are shaped by its environment. We choose to focus on the types of environment that reflects the core activity of technology-based new ventures - the technology commercialization process. Specifically, we distinguish between competitive (stand-alone) and cooperative commercialization environments, based on the effectiveness of intellectual property protection and the costs of complementary assets (Tripsas, 1997).

In a cooperative commercialization environment, new ventures tend to partner up with incumbent firms by forming alliances as opposed to directly competing with them. This type of environment is characterized by high degree of appropriability for inventions – typically in form of intellectual property (IP) protection – and high costs of assembling the requisite complementary assets, such as marketing, sales and distribution (Eesley et al., 2014; Gans &

Stern, 2003; Teece, 1986). For example, in sectors such as biotechnology, new ventures developing a new technology typically partner with established pharmaceutical firms that, in return for supplied innovation, take care of the subsequent steps, such as manufacturing and sales (Eesley et al., 2014). As creating an alliance typically involves innovation disclosure, strong appropriability effectiveness makes cooperation possible. At the same time, high costs of assembling requisite complementary assets make cooperation between incumbents and newcomers a desirable strategy for new ventures that otherwise would not be able to build their own complementary assets. Because new ventures in cooperative environments may make use of the assets supplied by the collaborator firm, they experience lower need to develop their own internal capabilities of their team. Hence, the pressure to adjust the team is lower.

Competitive (stand-alone) commercialization environment (e.g., software, consumer products, law, consulting and other services sectors), in contrast, is characterized by low degree of appropriability and low costs of assembling complementary assets. New ventures operating in this environment are not in the position to form partnerships with the existing firms within the industry, as risky disclosure of their innovation would imply potential loss of their competitive advantage. Instead, they compete with the incumbent firms and need to make an investment into developing their own complementary assets. Consequently, these firms are faced with stronger need to continuously update the capabilities of their management team and hence are more likely to proactively change its composition.

Hypothesis 5. New ventures operating in a competitive (stand-alone) commercialization environment are more likely to hire new managers.

5.2.4. Environmental contingency

The type of commercialization environment has a direct effect on new member addition, but it may also strengthen the effects of new ventures' team and organizational characteristics – its founding team's human capital and board characteristics. Generally, new ventures operating in a competitive (stand-alone) commercialization environment are faced with higher pressures to continuously develop capabilities necessary to manage evolution of their organization. This relationship becomes stronger for teams whose (1) human capital lacks managerial experience and is susceptive to the environmental cues signaling need for change, (2) boards provide them with external funds and are independent in their decision-making.

For instance, technologically specialized teams will experience stronger need to augment their team in competitive rather than cooperative commercialization environments. To develop internal complementary assets, new ventures operating in competitive commercialization environments need to develop a set of capabilities that go beyond technological expertise (Eesley et al., 2014). Teams that solely consist of engineers and scientists are unlikely to internally develop important capabilities, such as marketing, sales, and distribution, to successfully compete with incumbent firms. Hence, these teams will experience stronger pressures to develop their team externally by hiring a new manager with the complementary expertise. Conversely, within the cooperative environment, rather than competing with the established firms, new ventures compete with each other in developing a superior technology that they can supply to an incumbent firm (Gans & Stern, 2003; Eesley et al., 2014). Technological excellence and focus play an important role, as achieving technological milestones, such as completion of design, proof-of-concept, and prototyping, defines success of these ventures. Changing the setup of the technological specialist team may disrupt important team processes, hampering effectiveness and tacit knowledge transfer, which are the source of competitive advantage for these teams. Hence, change within the

technologically specialized teams operating in a cooperative environment may not only be superfluous, but also detrimental.

The positive relationship between team's prior start-up experience and its likelihood to hire new managers will also be stronger in competitive as opposed to more cooperative commercialization environments. Founding teams with prior start-up experience are better at identifying environmental cues that signal need for change. These cues are more salient in competitive commercialization environments, as fierce competition with incumbent firms requires them to develop a wide set of internal managerial capabilities (Gans & Stern, 2003; Eesley et al., 2014). Conversely, in more cooperative environments, the environmental cues for change are less pronounced, making it more likely for them to remain unnoticed. Thus, the ability to adapt to changing environmental demands in founding teams with prior start-up experience will be stronger depending on the degree of competitiveness of the commercialization environments.

In the similar vein, we expect the positive relationship between board oversight and new managerial hire to be stronger in competitive as opposed to more cooperative environments. Due to their unwillingness to give up control over their venture, founding teams may be resistant to implement change within their team, raising the need of boards to step in to initiate compositional change. The more independent the board, the more likely it is to address competence shortages within the management team. It is reasonable to expect board involvement to be more frequent in environments in which development of managerial capabilities is critical for new venture success. Because development of internal managerial capabilities is more salient in competitive environments, we expect that the positive relationship between board independence and new managerial hire is stronger in these competitive environments.

Furthermore, we expect the positive relationship between external investment and new managerial hire to be stronger in competitive as opposed to more cooperative environments. Designing a new position and attracting experienced candidates require substantial financial resources, specific managerial know-how, as well as broad social network, which in case of new ventures, tend to be scarce. External investors provide financial resources that may be used to professionalize firms processes and structures (Ferguson et al., 2016; Wasserman, 2003). They also supply new ventures with strategic advice and make frequent use of their professional network to help recruiting experienced managers (Faber, Castaldi, & Muskens, 2016; Ferguson et al., 2016). Because in competitive commercialization environment the need for new managerial capabilities is higher, we expect external investors to be more actively involved in providing necessary support to recruit new managers in companies operating in more competitive environments.

Hypothesis 6. The effects of change antecedents (founding team's prior start-up experience, technological specialization, board independence, and VC involvement) are strong in new ventures operating in a competitive (stand-alone) but not in a cooperative commercialization environment.

5.3. Data and methods

5.3.1. Sample

The list of technology-based new ventures in Flanders was obtained through the IWT – the Flemish Agency for Innovation by Science and Technology. The IWT is a governmental agency that aims at supporting innovation in Flanders, both within academia and industry. One of its programs provides grants to technologically advanced new ventures. Most of entrepreneurs starting this kind of ventures in Flanders apply for these grants, as they represent

one of the most accessible ways of receiving seed capital of up to 50,000 Euros. Furthermore, IWT actively encourages entrepreneurs to apply for these funds and supports them with preparing proposals. IWT provided us with the contact information of all the applicants for these grants, regardless of whether their application was successful or not. The IWT endorsed this study, increasing the face validity and the likelihood of higher response rate. We recorded information about all the firms on the list (including successful and unsuccessful applicant-firms), making sure that our sample is not subject to self-selection.

The lists of new ventures and their contact information were yearly provided by IWT starting with 2009. Based on these lists, the annual data collection was conducted. After retrieving information about the founding years of these ventures from BELFIRST database, companies that were more than 3 years old at the time of the first observation were eliminated from the sample. Overall, 258 companies were identified and contacted. Out of this total number of firms, 169 (66%) participated in the study by completing a questionnaire at some point of time. The mixture of secondary and primary data collection was used to construct a database. Due to the missing information, the final dataset resulted in 148 firms. The overall collected information on these firms is summarized in an unbalanced panel dataset of 634 annual observations.

We use a panel data with an observation (spell) for each year starting with the firm's legal formation, as we are interested in the effects of both constant and yearly time-varying explanatory variables. Overall, 44 (30%) firms in our sample have experienced new managerial hires at some point of time. Some of these firms have experienced more than one entry to the team, resulting in the total of 58 events and 85 individuals being hired. In this study, we are specifically interested in the first managerial hire. We believe that after its first compositional change, managerial team has to renegotiate its processes and routines, whereby, different

mechanism may emerge to motivate subsequent hires. We hence, perform a single-event per subject analysis.

It needs to be noted that certainly not all newly hired managers will enhance new ventures' managerial expertise. As prior research has pointed out, the forces of homophily strongly prevail within the executives' turnover (Boone, van Olfen, van Witteloostuijn, & De Brabander, 2004; Ruef et al., 2003; Westphal & Zajac, 1995), as managers tend to favour newcomers with similar set of skills to their own. Yet the decision to hire a new manager into the new venture team is the first and conditional step towards increasing its functional diversity to develop a professional top management team.

5.3.2. Variables

New managerial hire. New managerial hires, defined as new member additions to the new ventures' management teams, are observed on yearly basis. Within the total number of 148 new ventures in our sample, 44 (30%) have experienced new member additions at some point of time. We hence record, 44 events of first team member addition. Event is coded as dummy variable with the value 1, if the venture has experienced a new member addition, and the value 0, if it did not.

Commercialization environment. In line with prior research (e.g., Eesley et al., 2014; Gans & Stern, 2003), we distinguish between two types of commercialization environment – competitive and cooperative – based on the intellectual property rights (IPR) protection and the asset complementarity surrounding new venture's technology. We define and assess IPR protection by the patent effectiveness measure. When patent effectiveness is high, new ventures are more likely to disclose their innovation in order to form an alliance with incumbent firms. Complementary assets are defined as firm's capabilities and assets that assist innovation through its commercialization process (Teece, 1986). Such capabilities may include

manufacturing expertise, customer knowledge, marketing and sales. Combined, the IPR protection and the assets complementarity describe the type of commercialization environment based on the hazards associated with both (a) contracting for complementary assets and (b) threats of potential imitation – an approach that has been frequently used by prior research (Eesley et al., 2014; Gans & Stern, 2003).

Competitive (stand-alone) commercialization environment is defined as a context in which IPR protection is weak, while development of complementary assets is essential and cost-effective (i.e., new ventures can and must develop their own complementary assets). This type of environment depicts industries in which, due to low patent effectiveness, bargaining with incumbents is risky, while entry costs are relatively low and new ventures are expected to develop their own complementary assets. In contrast, cooperative environment is defined as an environment with high IPR protection and high costs of complementary assets. New ventures in this environment are more confident in bargaining with incumbent firms, due to the legal protection of their innovation. Due to the high costs of developing complementary assets, they cannot invest in developing their own complementary assets and are therefore inclined to make use of those provided by the incumbent firms.

Focusing on the IPR and complementary assets allows us to distinguish between two environments based on well-defined patterns, as both the technological disclosure (in form of IPR) and the costs of complementary assets reinforce the same strategy – either cooperative (when the complementary assets are costly and disclosure problem is less pronounced) or competitive (when the complementary assets are cost-effective and disclosure is problematic) strategy (Gans & Stern, 2003). Consistent with the notion that patent effectiveness and complementary assets are part of one construct of commercialization environment, the two are highly correlated in our sample (r =.90, see Table2 for descriptive statistics). Grouping industries based on the importance of their complementary assets and IPR dimensions is a

method grounded in the prior literature and allows for classification of industries based on well-defined characteristics.

Following the approach of Eesley and colleagues (2014), we measure industries' patent effectiveness and importance of complementary assets by matching industry sectors in our sample with the industry scores from the Carnegie Mellon University (CMU) Industry R&D survey (Cohen, Nelson, & Walsh, 2000), using the Standard Industrial Classification (SIC) code, which we obtained from BELFIRST database. Sectors scoring high on patent effectiveness include medical equipment, biotechnology, and pharmaceutical manufacture. Sectors scoring low are printing and publishing, food manufacture, software, data processing and ICT. Sectors scoring high on importance of complementary assets include printing and publishing, textile manufacture, biotechnology and chemicals. Scoring low are software, electrical equipment, services, and plastic (see Appendix 5.6.1, Operationalization of commercialization environment, for the detailed description of our methodological approach). To describe a commercialization environment that is characterized by both patent effectiveness and complementary assets costs, we create a mean value after initially standardizing the two measures. We then use the median value as the cut-off point to split the sample into two[22]: (1) comprising industries with weak patent effectiveness and low costs of complementary assets - competitive (stand-alone) commercialization environment (82 firms), and (2) comprising industries with strong patent effectiveness and high importance of complementary assets as cooperative environment (66 firms).

Technological specialist founding teams. In line with prior research, we define founding team as a group of entrepreneurs who founded the new venture (De Jong et al., 2013). Founding teams were classified as either technological specialists or non-specialists (mixed

[22] Additionally, we performed robustness analyses using the continuous measure of commercialization environment (see Appendix 5.6.2, Alternative operationalization of commercialization environment). The results (Appendix, Table 5.8.), which are discussed in more detail in the Supplementary analyses section, remain similar using both types of measure, suggesting appropriateness of our methods and the robustness of our findings.

teams) using an archetype-approach, based on the distribution of technology and market-related expertise among the founding team members. We distinguish between teams that are fully composed by individuals with strong technological background and no profound market knowledge, and the teams in which both technological and market expertise are represented. We refer to the former as technical specialist archetype.

To arrive at the founding team archetype classification, we reviewed founders' education and career histories. For each founder, we record whether he or she had received higher education in (1) technological domains, including science, engineering, ICT, and medical degree, (2) business- related domains, including organizational studies, business and economics, marketing and management, and (3) other domains, including not business-related social sciences, humanities and sport. We then record whether each of the founders had prior work experience in each of the aforementioned domains. Founding teams comprised of all members with technological education and work experience with no members holding business-related education or experience were classified as technological specialists. The rest of the teams, in which both technological, business-related and other type of education and experience are represented by its members, were classified as non-technological-specialists (mixed) teams. Finally, the founding team archetype was coded as dummy variable, with the value 1 for technological specialist (N=50) and value 0 for the mixed teams (N= 95) teams. This sample is comprised of 50 founding teams (34%) that were classified as 'technological specialists', yielding 255 (41%) of total observations.

In this study, we consider an extreme case of homogeneity within the founding teams, as all members of technological specialist teams are highly experienced in technological domain and possess no prior commercial, nor managerial experience. Over one third (34%) of new technology-based ventures belong to this archetype.

Founding team's prior start-up experience. We record whether at least one member of the founding team has established and managed a new firm in the past. We code a dummy variable, with value 1 for teams that had prior start-up experience before starting the venture of our focus, and value 0 if they did not. This information was obtained through the secondary data sources, such as web search, company's websites, and LinkedIn.

Board independence. For every year, we record the proportion of external board members who are not employed by the firm to measure board independence.

External investment. We obtain a yearly update about new ventures' external investment – venture capital, business angels, and industry investment – from annual accounts and interviews with founders. For each observation year, we code a dummy variable with the value 1 if new venture has received external investment and 0 if it did not.

5.3.3. Control variables

Based on the insights from prior studies, we include four control variables on team, organizational and macro levels of analysis that could potentially have an effect on new managerial hire.

Founding team size. Founding team size is measured as a count of members in the founding team. To account for its skewness, we take a natural logarithm. By including this variable, we control for any effect on new member addition as the result of the initial team size.

Team exits. New additions to the team may be result of founders' replacements. We hence, control for the founders' exits from the team. We use a dummy variable, with value 1 for teams that have experienced founder exits and value 0 for teams that have not. Because finding a suitable replacement candidate may take a longer period of time, we do not code this variable as time-variant but as a time-constant variable indicating whether or not the team has experienced member exits at any point of time prior the new managerial hire.

Starting capital. To control for the initial size of the venture, we include starting capital variable, of which we take a natural logarithm to account for its skewness.

Year of founding. To control for the general economic and environmental conditions at the time of founding, we include a dummy variable aggregating following founding years: before crisis (2006 - 2007), during crisis (2008 - 2009), and after crisis (after 2009).

5.3.4. Analysis

We analyse the rate of the first managerial hire in technology-based new ventures. First managerial hire can be regarded as an important milestone in the life of a new venture, we therefore use event-history analysis (also known as survival analysis) to analyze the occurrence of this event. We use Cox proportional hazard model estimated by Stata 13.1 using maximum likelihood estimation and report robust standard errors to account for observations clustering within firms. The Cox model is expressed by the hazard function denoted by *h(t)*,

$$h(t) = h0\ (t)\ exp(b_1x_1+b_2x_2+...+bpxp),$$

in which t represents the survival time, *h(t)* is the hazard function determined by a set of covariates $(x_1, x_2,...,x_p)$, the coefficients $(b_1,b_2,...,b_p)$ measure the impact (i.e., the effect size) of covariates, and the term h0 denotes the baseline hazard, which corresponds to the value of the hazard if all the xi are equal to zero. The hazard rate is defined as

$$r(t) = exp(b_i).$$

Cox regression is a non-parametric event-history model that has been frequently used within entrepreneurship research to examine the likelihood of a certain event, such as failure or completion of an organizational milestone (e.g., Beckman & Burton, 2008; Guenther, Oertel, & Walgenbach, 2015). Unlike parametric models, Cox regression neither imposes a specific shape on the hazard function nor requires an estimation of the baseline hazard, providing a greater flexibility and making it well suitable for our study. Prior the analysis, we examined

the appropriateness of this model, by testing for the two key assumptions posed by the Cox proportional hazard model. First, we assess whether our study design satisfies the assumption of non-informative censoring, which suggests that the time to censorship distribution is not related to the time-to-event distribution. New ventures may disappear from our sample due to two reasons: (a) they cease their business (fail), or (b) they no longer wish to participate in our study (drop-out). Although, new ventures' failure may be due to inadequate management, prior research was not able to establish a straightforward relationship between new member addition and new venture success, as the results remain mixed and inconsistent (e.g., Beckman et al., 2007; Chandler et al., 2005; Chandler & Lyon, 2009; Guenther et al., 2015). New ventures' wish to drop-out of our study is unlikely to relate to their propensity to hire a new manager. It is therefore reasonable to assume that our study design satisfies the assumption of non-informative censoring, as the mechanisms behind censoring of the ventures are not meaningfully related to the probability of the event. Second, we performed a proportional hazard test to assess whether the relative risk of new ventures with different covariate values is constant at all times. The test confirmed the proportionality assumption. We further plotted the survival distribution functions for different groups to visually assess this assumption (see Figure 5.4 and Figure 5.5, in Appendix 5.6.3). Figure 5.4 depicts the survival distribution functions for new ventures with technological specialists founding teams versus non-specialists. Figure 5.5 depicts the survival distribution functions for new ventures that have obtained external funds versus those that did not. The distributions across the groups in both of these plots are relatively parallel, suggesting that our study also satisfies the assumption of proportional hazards. Cox proportional hazard model is therefore, well suitable and appropriate for our research.

In the present study, the event of the interest is the first managerial hire. In our analysis, time is the age of the firm (in years) and the event is the year in which a new managerial hire

took place. Our theoretical development suggests that the event of a first managerial addition in technology-based new venture teams is influenced by both time-constant and time-varying factors. Therefore, we use time-constant and time varying predictor variables in our model. Variables that are time-constant include the controls for founding team size, new venture's size at founding, and the year of founding. Time-constant predictors include founding team's archetype either as a technical specialist team or not, founding team's prior start-up experience, and the type of the commercialization environment (cooperative versus competitive commercialization). Time-varying variables include team exits, board independence, and external investment.

5.4. Results

Table 2 contains summary statistics and bivariate correlations. The correlations between the variables of our interest are low to moderately low, with the highest correlation (r = .63) between external investment and board independence. As external investors are also outside-directors, the two variables are interrelated. We hence perform our analyses entering these two variables into our models separately. We also performed analyses in which we entered the two variables simultaneously into the model, which did not alter substantively our results. We further examine the model fit across different models and find our results robust with and without various control variables.

Table 5.2. Variable descriptive statistics

Variable	Mean	Std. Dev.	Min	Max
FT size	2.18	1.11	1	7
Team exits	.04	.22	0	2
Starting Capital	51,124.58	140,187.8	0	186,5000
Technological specialists	.35	.48	0	1
Prior start-up experience	.24	.36	0	1
Board independence	.23	.31	0	1
External investment	.40	.49	0	1
Competitive environment	.54	.50	0	1

Correlation matrix

	1	2	3	4	5	6	7	8	9
1. FT size	1.00								
2. Team exits	0.15	1.00							
3. Starting Capital	0.14	0.05	1.00						
4. Technological specialists	-0.06	0.01	0.05	1.00					
5. Prior start-up experience	0.04	0.08	0.05	-0.15	1.00				
6. Board independence	0.31	0.13	0.29	0.04	0.06	1.00			
7. External investment	0.16	0.12	0.11	-0.03	0.11	0.63	1.00		
8. Competitive environment	0.09	-0.03	-0.07	0.10	-0.04	-0.13	-0.17	1.00	
9. Patent effectiveness	-0.00	0.04	0.06	0.04	-0.01	0.22	0.22	-0.82	1.00
10. Complementary assets	0.01	0.02	0.02	0.08	-0.04	0.14	0.15	-0.82	0.90

Figure 2 depicts a density plot of a first managerial hire against new ventures' age (in years). It shows that the most additions to the team occur between the years 3 and 6 after new ventures' legal founding. This is in line with the life cycle argument that as new ventures develop they need to augment the composition of their team. Figure 3 represents percentage of new ventures that do not hire new managers over time, clustered by the type of (cooperative versus competitive) commercialization environments. In line with our argumentation, the graph clearly shows differences between the two lines indicating that the percentage of new ventures not hiring new managers over time is higher in cooperative than competitive commercialization environments.

Figure 5.2. Events of a first managerial hire against new ventures' age

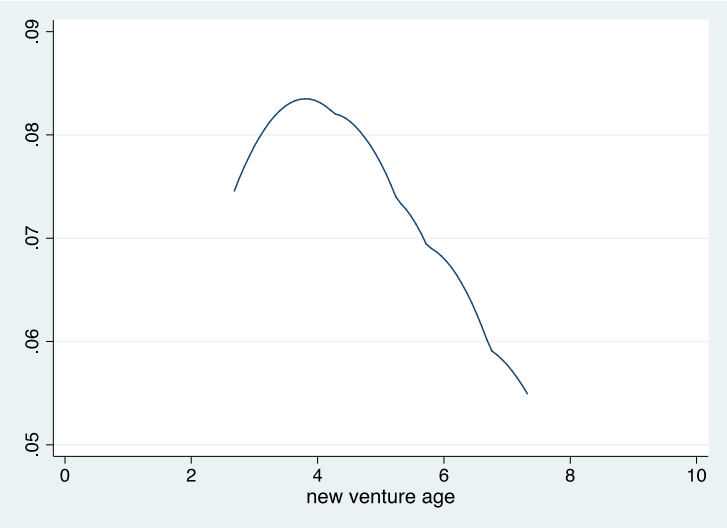
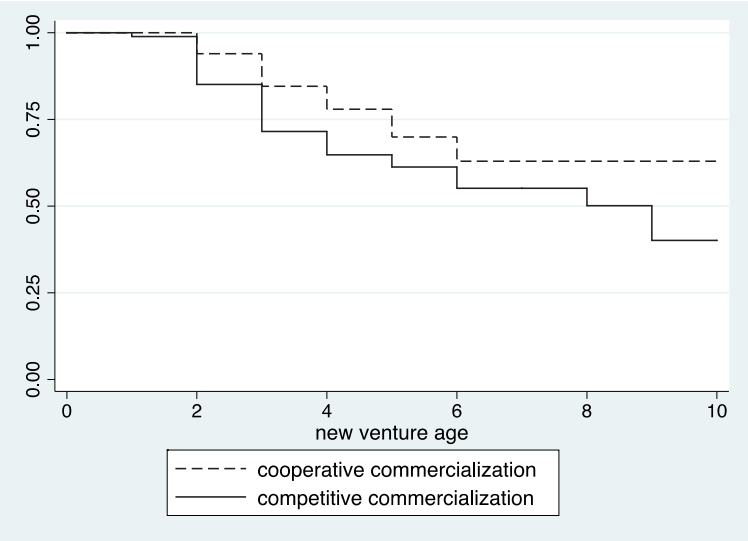


Figure 5.3. Likelihood of not hiring new managers over time by



We present the results (coefficients and robust standard errors) of our Cox regression models in Table 3. Model 1 is the baseline model that includes main effects of our control variables. Team size is positive and significant suggesting that larger teams are better at adding new team members. In line with prior research and our expectations, team exits are positive and

significant indicating that new hires often occur as a result of founder replacements. As expected, these variables are significant across the models.

Models 2 to 6 depict the main effects of our independent variables individually and Model 7 and 8 show effects of these variables when entered simultaneously. Hypothesis 1 stated that technological specialist teams are more likely to hire new managers. We test this hypothesis in our Model 2. The coefficients for technological specialist teams are positive yet insignificant (although close to the $p < 0.1$ levels). The coefficient becomes significant ($p < 0.05$, two-tailed tests) when all predictors are entered into the model (Model 8). The hazard rate of technological specialist founding teams is 1.80 ($r(t) = \exp(.59)$), indicating that these teams are 80% more likely to hire new managers. We thus, find support for our hypothesis 1. Hypothesis 2 stated that teams with prior start-up experience are more likely to add new managers. Model 3 provides evidence to support this hypothesis. The coefficient for prior start-up experience of the founding team is positive and highly significant ($p < 0.01$, two-tailed). The hazard rate is 2.71 ($r(t) = \exp(1.00)$), indicating that a unit increase in prior start-up experience is associated with a substantial increase in new ventures' propensity to hire a new manager. Hypothesis 3 stated that teams with independent boards are more likely to hire new managers. In line with prior research and our expectations, the coefficient for board independence is positive and highly significant ($p < 0.01$, two-tailed), indicating that outside board members play an important role in initiating new hires to the team. The hazard rate is 3.99 ($r(t) = \exp(1.38)$), indicating that a unit increase in boards' independence translates into a substantial increase in new ventures' propensity to hire a new manager. We hence, confirm hypothesis 3 (Model 4). Hypothesis 4 stated that teams that obtain external investment are more likely to hire new managers. Model 5 provides support for this hypothesis. The coefficient for board independence is positive and significant ($p < 0.05$, two-tailed tests), indicating that external investment is an important antecedent of new managerial hires. The hazard rate is 2.08

(r(t) = exp(.73)), indicating that new ventures that have obtained external funding are significantly more likely to hire new managers. Hypothesis 5 states that teams operating in a competitive (stand-alone) commercialization environment are more likely to hire new managers. In line with our expectations, the coefficient is positive and significant ($p < 0.05$, two-tailed). The hazard rate is 2.09 (r(t) = exp(.74)), indicating that new ventures operating in competitive environments are more likely to hire new managers. We hence confirm this hypothesis (Model 6).

In Models 7-9 we examine the independent and relative effects of each of our predictors by entering all of these variables into one function. Because of high correlation between board independence and external investment, we first enter these variables separately (Models 7-8) and then simultaneously (Model 9). In the Model 7, the largest effect size is of board independence (r(t)=5.50), followed by founding teams' prior start-up experience (r(t)=3.38), competitive commercialization environment ((r(t)=2.27), and technological specialists teams ((r(t)=1.78). In the Model 8, the largest effect size is of founding teams' prior start-up experience (r(t)=4.01), followed by external investment (r(t)=2.66), competitive commercialization environment ((r(t)=2.20), and technological specialists teams ((r(t)=1.82). In the Model 9, the significance levels of board independence and external investment drop due to the high correlation between the two variables. The larges effect size in this model is of teams' prior start-up experience ((r(t)=3.99), followed by board independence (((r(t)=3.29), competitive environment ((r(t)=2.27), technological specialists teams (((r(t)=1.80), and external investment ((r(t)=1.77). Based on these and the independent analyses of each of the predictors, we conclude that prior start-up experience and board independence have the strongest effects on new member additions in technology-based new venture teams, followed by competitive environment and external investment. Having a technological specialist founding team has the weakest effect on new managerial hire.

Table 5.3. Effects of multi-level antecedents on the likelihood of a new managerial hire

Cox proportional hazard model – Coefficients and robust standard errors [a]

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
FT size (log)	.64**	.64**	.65**	.36	.55*	.54*	.33	.52*	.36
	(.29)	(.30)	(.26)	(.31)	(.29)	(.28)	(.28)	(.27)	(.28)
Team exits	.81**	.86**	.78**	.86**	.81**	.92***	.91***	.83***	.84**
	(.34)	(.34)	(.34)	(.34)	(.33)	(.33)	(.35)	(.31)	(.34)
Starting capital (log)	.07	.06	.06	-.05	-.01	.08	-.11	-.03	-.11
	(.11)	(.12)	(.10)	(.10)	(.11)	(.11)	(.09)	(.10)	(.09)
Founding year:									
crisis	-.03	-.04	.05	.03	.01	-.01	.18	.27	.27
	(.31)	(.31)	(.31)	(.31)	(.30)	(.31)	(.30)	(.30)	(.29)
Tech. specialists		.43					.58*	.60**	.59**
		(.30)					(.30)	(.29)	(.30)
Start-up experience			1.00***				1.22***	1.39****	1.38****
			(.38)				(41)	(.39)	(.43)
Board independence				1.39***			1.70***		1.20*
				(.52)			(.54)		(.67)
External investment					.73**			.98***	.57
					(.33)			(.34)	(.42)
Competitive envir.						.74**	.82***	.79***	.83***
						(.32)	(.32)	(.31)	(.31)
Wald chi-square (degrees of freedom)	15.88*** (4)	19.54**** (5)	25.09**** (5)	29.70**** * (5)	24.58**** * (5)	27.40**** * (5)	58.56**** * (8)	55.61**** (8)	59.27**** (9)

[a] Number of ventures is 148; number of new hires is 44; number of observations is 634

*p<0.10; ** p<0.05; *** p<0.01; **** p<0.001, two-tailed test

Next, we examine the effects of new ventures' environmental fit. Hypothesis 6 stated that the effects of change antecedents (founding team's prior start-up experience, technological specialization, board independence, and VC involvement) are strong in new ventures operating in a competitive (stand-alone) but not in a cooperative commercialization environment. To test this hypothesis, we first examine the interaction effects of each of our independent variables with commercialization environment (Table 4). In contrast to our expectations, none of the interactions is significant. For a more in-depth analysis, we split the sample into two: one representing ventures that operate in cooperative commercialization environment (N=66), and the second representing ventures operating in competitive (stand-alone) commercialization environment (N=82) and investigate the effects of our predictors in each of these subsets (Tables 5 and 6). In contrast to our expectations, there is no significant difference between the coefficients in the two sub-samples. We hence, find no support for our hypothesis 6.

Table 5.4. Environmental fit and the likelihood of a new managerial hire

Cox proportional standard model – Coefficients and robust standard errors [a]

	Model 1	Model 2	Model 3	Model 4	Model 5
FT size (log)	.55*	.54**	.23	.45	.40
	(.30)	(.27)	(.30)	(.29)	(.29)
Team exits	.97***	.90***	.95***	.97***	.92**
	(.35)	(.33)	(.35)	(.34)	(.37)
Starting capital (log)	.07	.06	-.06	-.01	-.10
	(.12)	(.11)	(.10)	(.12)	(.10)
Founding year:					
crisis	-.02	.06	.10	.03	.26
	(.30)	(.31)	(.30)	(.29)	(.30)
Competitive Comm. Envir.	.84*	.70*	.95*	1.36**	1.52
	(.45)	(.42)	(.54)	(.67)	(1.07)
Tech. specialists	.59				.64
	(.57)				(.55)
Tech. specialists X Competitive Comm. Envir.	-.22				-.03
	(.69)				(.67)
Start-up experience		.97			1.55**
		(.61)			(.76)
Start-up experience X Competitive Comm. Envir.		-.09			-.20
		(.77)			(.89)
Board independence			1.76**		1.24
			(.90)		(1.06)
Board independence X Competitive Comm. Envir.			-.14		.11
			(1.03)		(1.30)
External investment				1.43**	1.24
				(.71)	(.88)
External investment X Competitive Comm. Envir.				-.82	-1.03
				(.78)	(1.00)
Wald chi-square (degrees of freedom)	29.89***** (7)	34.42***** (7)	45.68***** (7)	37.64***** (7)	56.28***** (13)

[a] Number of ventures is 148; number of new hires is 44; number of observations is 634

*p<0.10; ** p<0.05; *** p<0.01; **** p<0.001, two-tailed test

Table 5.5. Effects of the multi-level antecedents in competitive environments

Cox proportional hazard model – Coefficients and robust standard errors [b]

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
FT size (log)	.40	.43	.37	.18	.37	.26	.39	.27
	(.33)	(.35)	(.31)	(.35)	(.33)	(.34)	(.32)	(.34)
Team exits	1.54****	1.45*****	1.639*****	1.27****	1.30****	1.23***	1.24***	1.19***
	(.35)	(.37)	(.36)	(.38)	(.37)	(.41)	(.39)	(.43)
Starting capital (log)	.03	.05	.00	-.10	-.03	-.11	-.05	-.11
	(.15)	(.17)	(.13)	(.13)	(.15)	(.12)	(.13)	(.12)
Founding year:								
crisis	.07	.55	.16	.24	.13	.35*	.32	.37
	(.36)	(.36)	(.36)	(.35)	(.34)	(.35)	(.36)	(.35)
Tech. specialists		.29				.56	.57	.56
		(.34)				(.36)	(.36)	(.37)
Start-up experience			.94**			1.27***	1.44***	1.33**
			(.47)			(.49)	(.51)	(.53)
Board independence				1.70***		1.64**		1.42*
				(.69)		(.67)		(.86)
External investment					.60		.78*	.22
					(.41)		(.41)	(.51)
Wald chi-square	35.07*****	33.47*****	40.67*****	44.82*****	39.46*****	54.76*****	52.88****	55.19*****
(degrees of freedom)	(4)	(5)	(5)	(5)	(5)	(7)	(7)	(8)

[b] Number of ventures is 82; number of new hires is 31; number of observations is 332

*p<0.10; ** p<0.05; *** p<0.01; **** p<0.001, two-tailed test

Table 5.6. Effects of the multi-level antecedents in cooperative environments

Cox proportional hazard model – Coefficients and robust standard errors [c]

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
FT size (log)	.78	.73	.96	.38	.60	.54	.96*	.76
	(.60)	(.61)	(.62)	(.67)	(.62)	(.64)	(.57)	(.59)
Team exits	.24	.36	.06	.37	.34	.37	.18	.27
	(.68)	(.70)	(.64)	(.76)	(.73)	(.75)	(.66)	(.72)
Starting capital (log)	.11	.07	.13	-.03	.00	-.10	.01	-.08
	(.15)	(.16)	(.14)	(.15)	(.19)	(.16)	(.15)	(.16)
Founding year:								
crisis	-.20	-.22	-.09	-.25	-.25	-.22	.05	.00
	(.57)	(.57)	(.55)	(.57)	(.56)	(.57)	(.55)	(.56)
Tech. specialists		.47				.59	.56	.63
		(.60)				(.59)	(.59)	(.59)
Start-up experience			1.15*			1.23*	1.47**	1.61**
			(.60)			(.73)	(.66)	(.80)
Board independence				1.53		1.77		1.08
				(.99)		(1.01)		(1.14)
External investment					1.25		1.39*	1.15
					(.77)		(.79)	(.88)
Wald chi-square	2.59	4.41	5.86	6.19	7.90*	8.58	8.14	12.55
(degrees of freedom)	(4)	(5)	(5)	(5)	(5)	(7)	(7)	(8)

[c] Number of ventures is 66; number of new hires is 13; number of observations is 302

*p<0.10; ** p<0.05; *** p<0.01; **** p<0.001, two-tailed test

5.4.1. Supplementary analyses

We ran supplementary analyses with different variations of independent variables to examine the robustness of our results (see Appendix 5.6.1, Table 5.8). The results are robust to using to alternative operationalization methods of our key variables, such as a continuous measure for the commercialization environment (Table 5.8, Models 1-2). Our commercialization environment measure relies on the scores from the CMU survey that was administered in 1994. Despite the use of this method by more recent work (e.g., Eesley et al., 2014) this may raise questions of whether the scores have remained unchanged until the timeframe of our study, particularly because industries and patent effectiveness thereof are likely to change over time (Cohen et al., 2000). We therefore performed additional analyses to address this issue by looking at the particular sectors. Competitive commercialization environment within our sample is largely comprised of software, business services, data processing and other type of services. Because Software industry is known to have low patent effectiveness and low costs for complementary assets, we perform analyses using this sector as a proxy for competitive commercialization environment. Our results remain unchanged (Table 5.8, Model 3). However, business and services sector is not significant (Table 5.8, Model 4). Cooperative commercialization environment in our sample is to the largest extent comprised of biotech and pharma industries. These industries are known for long product development cycles, which are typically based on patented research. Patenting in these sectors is the common method for young firms to secure their competitive advantage, while costs of developing complementary assets are high. Measuring cooperative environment in terms of these sectors did not alter our results (Table 5.8, Model 5).

Overall, a number of supplementary analyses indicates that our results are robust across various model specifications and variable operationalization. Although, to avoid overfitting the model we had to keep the number of our predictors low, we tried to control for all relevant

influences that could affect propensity of a new managerial hire in a young start-up. The small number of cases in the sub-sample analyses could limit our ability to detect interactions, as the number of observations and especially the number of events in each of the subsamples (particularly in cooperative commercialization environment, $N_{firms}=66$; $N_{events}=13$) are low.

5.5. Discussion

Prior work within entrepreneurship literature has illustrated critical difference between starting and successfully managing a new venture. Building on the life-cycle perspective of a firm, present study examines effects of new venture characteristics, related to its founding team, board and commercialization environment. Our main findings are that the professionalization process of the new venture team depends on forces operating at different levels of analysis. On team level, the need to hire a new manager is high when the founding team has no managerial experience, while the opportunity to change is high if the founding team has had prior start-up experience. On organizational level, the ability to implement change is amplified by board independence and external investment. On environmental level, new ventures that operate in competitive (stand-alone) commercialization environment experience stronger need to continuously update capabilities of their team and are therefore more likely to hire new managers. The main advantage of our approach is that it allows us to evaluate the unique contribution of each of these antecedents contributing to the ongoing debate about what characteristics matter the most in new ventures development and growth. We find that teams' prior entrepreneurial experience and board independence are the strongest predictors of a new managerial hire, followed by external investment and competitive commercialization environment. Surprisingly, lack of relevant commercial and managerial experience is the weakest predictor of a new managerial hire.

These findings offer several new insights. On the team-level, previous studies have predominantly focused on the human capital characteristics, such as team diversity, industry experience, relational capabilities, and under-qualification, suggesting that teams with less capabilities will be more likely to hire new managers to enhance these capabilities (Boeker & Wiltbank, 2005; Brinckman & Hoedl, 2011; Chandler et al., 2005; Ferguson et al., 2016; Ucbasaran et al., 2003). Building on these insights, we examined the role of teams' technological specialization as the most salient indicator of human capital within technology-based new ventures. On the one hand, it reflects shortage of commercial and managerial capability necessary to manage new ventures' growth. On the other hand, scholarly literature and popular press have suggested that technology-based new ventures typically start-up with technical founding team, which they subsequently professionalize by hiring more seasoned managers (Eesley et al., 2014; Beckman & Burton, 2008). Consistent with prior research, we found that teams without important commercial and managerial experience are more likely to hire new managers. Additionally, we examined the role of teams' prior start-up experience - as the attribute that signals teams' capacity to implement change. This type of team characteristic was not addressed by prior research. As new managerial hire is not only a function of capability shortage, it also requires a skill to detect and to realise this need. We argued that experienced entrepreneurs will be more susceptive to environmental cues and hence more responsive to the need to augment their team. We found support for our hypothesis. Moreover, we found that prior start-up experience is a stronger team-level predictor of a new managerial hire than teams' technological specialization.

New ventures' organizational characteristics have gained less attention by prior research. Despite the importance of boards in new ventures' strategic decision-making and staffing, only few studies examined their role in new ventures' evolution of management teams, whereby the most comprehensive studies focused on founders' dismissal (Boeker & Karichalil,

2002) and team turnover (Boeker & Wiltbank, 2005), but not on new managerial hires. Building on and extending the insights generated by these studies, we examined the role of boards in new managerial hires in technology-based start-ups. Although, prior research did not establish a relationship between board independence and the general membership change (Boeker & Wiltbank, 2005), we found that it mattered for new member addition. This finding highlights the importance of boards in development of a new ventures' managerial capabilities. In line with our predictions and prior research, which found external investment to be related to general change (Boeker & Wiltbank, 2005), we found it important for new member addition. Both board independence and external investment are amongst the variables with the strongest association to the new managerial hire.

In addition to the team and organization's characteristics, we examined the role of environment as a driving force to update team's human capital. To date only one study examined the role of environment in new member additions (Chandler et al., 2005), which is surprising given that new ventures' environment has direct implications for the team (Eesley et al., 2014). Focusing on the environmental dynamism versus stability, Chandler and colleagues (2005) found that dynamism was positively related to new member additions. We complement this line of research by focusing on the attributes of the environment that reflect the most salient features of the technology-based start-ups – namely their strategy to commercialize technology or service. This framework allows us to examine the more fine-grained features of the environment based on how technologies and innovations are introduced across different sectors. We distinguished between two types of commercialization environment – competitive and cooperative – based on the degrees of intellectual property rights effectiveness and the asset complementarity surrounding new venture's technology. Focusing on the two clearly defined types of environments enables a deeper insight into what specific opportunities and requirements arise from these environments in order to maximize

returns, as well as into how they translate into the professionalization strategies of the team. We found competitive commercialization environment strongly associated with a new managerial hire.

Given the strong implications that the environment has on the capabilities development of the team, we have also aimed to examine the effects of environmental contingency in aligning team and organizational characteristics with new venture's commercialization strategy. To our This is the first paper to take an interaction approach to examine the role of environmental "fit". However, due to the small sample and a low number of events (N=13 in cooperative environment), we were not able to produce meaningful results with regard to this hypothesis and encourage future research to consider environmental contingency when studying evolution of managerial capabilities in technology-based new ventures.

Finally, our unique longitudinal dataset that comprises detailed information on founders and their firms allows us to advance existing knowledge empirically. Most prior studies have relied on self-reports and worked with cross-sectional datasets. We have constructed an extensive dataset comprising detailed information on innovative technology-based new ventures, their founders, investors, boards and industries. This large-scale data collection effort resulted in detailed information about 148 Flemish new ventures founded between 2006 and 2015, which was updated annually starting with 2006. The longitudinal nature of this dataset allows us to obtain real-time insights on the development of the firm, including its management team. By employing this detailed data on European start-ups, we also contribute to the existing research, which has predominantly examined MIT and Silicon Valley start-ups (e.g., Beckman & Burton, 2008; Boeker & Wiltbank, 2005; Fergusson et al., 2015), which constitute a very peculiar context and do not represent the larger proportion of technology-based start-ups across the globe.

5.5.1. Limitations and future directions

This study offers a broad, multi-level view of some of the core antecedents of new managerial hires in technology-based start-ups. While it makes several important contributions, it is not free of limitations. First, while we predict new managerial additions to the entrepreneurial firms, we do not know whether these additions have positive or negative effects on team's and new venture's performance. Following the insights from the life-cycle literature, we adopt an implication that all entrepreneurial firms need new professional managers to add skills and capabilities to the initial founding team. Additional capabilities may facilitate superior decision-making and signal quality to potential stakeholders, thus increasing new venture chances of success. At the same time, they may disrupt important team processes and pose additional turbulence to already-turbulent entrepreneurial firms (Guenther et al., 2015). Future studies should incorporate measures of new venture performance to better understand whether new managerial hires are beneficial or detrimental for new ventures development.

Next, we examined the likelihood of a new managerial hire without distinguish between the different types of capabilities that a new member brings to the team. It would be reasonable to expect that individuals bringing in new skills complementary to the incumbent team are more beneficial for new ventures' development and success than those that bring expertise which is already available to the team. Future research could examine in more detail whether the capability enhancement or homophily are the strongest driving forces of new managerial hires. Furthermore, a deeper understanding of the types of managerial profiles that are more suitable for evolving firms would offer practical insights to new venture teams, investors, governments and other stakeholders. We examined the antecedents of a new managerial hire on team, organizational and environmental levels of analysis. Future research could examine individual-level factors related to the lead founder and the CEO. Finally, we aimed at examining the environmental contingencies of both team and firm-level characteristics.

However, due to the small sample size and a small number of events our dataset proved to be not suitable for testing fit hypotheses. We therefore would like to encourage future research to consider environmental fit of team and firm-level characteristics in studying new ventures' managerial evolution.

5.5.2. Practical implications

This paper highlights the importance of team, board and environmental characteristics as predictors of hiring in nascent entrepreneurial firms. Lacking important knowledge resources increases the need for a new hire, while prior start-up experience (and to some extent external investment) help to identify and realize this need. We have analysed the effects of characteristics inherent to the team and those that may vary over time. Inherent characteristics include those related to the founding team and new venture's environment. They are ingrained in the new firm and cannot be readily changed, making it particularly important to consider their effect for new ventures' long-term development. We find that technological specialisation facilitates new managerial hires, as firms seek to fill existing capability gaps. We also find that new ventures' whose founding teams do not have prior start-up experience have more difficulty to hire a new manager, possibly due to the lack of the relevant social capital needed to recruit a suitable candidate. Competitive commercialization environments favour compositional changes within entrepreneurial teams, as they exert higher pressures for teams to continuously update their capabilities. With regard to organizational characteristics that change over time, we find that independent boards and external investment facilitate new managerial hires. The aim of this paper is to highlight the need for new ventures to update their team capabilities over time to meet changing firm needs. We outline antecedents and moderators of these needs. Entrepreneurs and investors may benefit from proactively addressing these issues.

5.6. Appendix to Chapter 5

Appendix 5.6.1. Operationalization of commercialization environment

Following the approach of Eesley and colleagues (2014), we use the Carnegie Mellon University (CMU) Industry R&D survey (Cohen, Nelson, & Walsh, 2000) as the basis for deriving our measures. Spanning 1478 R&D labs in the U.S. manufacturing segment, Carnegie Mellon University (CMU) survey is a large-scale questionnaire aimed at assessing the effectiveness of a range of mechanisms typically used by firms across sectors to secure profits tied to their innovation. These mechanisms include patents, secrecy, lead time advantages and the use of complementary marketing and manufacturing assets (Cohen et al., 2000). The survey derived a score for the effectiveness of each of these mechanisms, by asking the respondents to report the percentage of their product and process innovations for which the mechanism has been effective during the prior three years (See Cohen et al., 2000 for the detailed description of the methods). With regard to the IPR protection and complementary assets, the original survey reported scores for the following six categories: product patent effectiveness, process patent effectiveness, product complementary assets for sales and services, process complementary assets for sales and services, product complementary assets for manufacturing and process complementary assets for manufacturing.

We match the sectors within our sample with the sectors within the CMU survey using the Standard Industrial Classification (SIC) code, which we obtained from BELFIRST database. We then create a measure of industry-level patent effectiveness by averaging product and process patent effectiveness scores. Sectors scoring high on this measure include medical equipment, biotechnology, and pharmaceutical manufacture. Sectors scoring low are printing and publishing, food manufacture, software, data processing and ICT. Similarly, we create an industry-level importance of complementary assets by averaging product and process complementary assets for sales, services and manufacturing. Sectors scoring high on this

measure include printing and publishing, textile manufacture, biotechnology and chemicals. Scoring low are software, electrical equipment, services, and plastic.

For sectors that could not be fit into the industries within the CMU data, we followed approach suggested by Easley and colleagues (2014). Service firms (e.g. consulting, health advice, and other business services) were grouped into "other services" category. As patents are likely to be ineffective and complementary assets unimportant for service firms, both of these measures are likely to be low (Eesley et al., 2014). Hence, we assigned the lowest values from the CMU survey to this group. The results of our analysis are robust to excluding these firms. Other sectors, such as electricity generation, civil engineering, wholesale of food and beverages and so on, remained unclassified.

We then use the median values of each of these measures as the cut-off point to split the sample into the firms that are in the environment in which patent effectiveness is strong and the importance of complementary assets is high (66 firms) and an environment in which patent protection is weak and the complementary assets less important (82 firms). Grouping industries based on the importance of their complementary assets and IPR dimensions is a method grounded in the prior literature and allows for classification of new industries based on these characteristics.

Appendix 5.6.2. Alternative operationalization of commercialization environment

Methods Continuous measure of commercialization environment

Table 5.7. Commercialization environment operationalized as industry sectors

Continuous measure of commercialization environment

To derive a continuous measure of commercialization environment, we first standardize and then average the measures of patent effectiveness and importance of complementary assets. The resulting measure indicates the cooperativeness of the commercialization environment – how likely it is for new ventures to pursue a cooperative commercialization strategy in a particular sector. Low scores represent sectors in which both, patent effectiveness and complementary assets importance are low, hence the likelihood of partnership and alliances between new ventures and incumbent firms is rather low. High scores represent sectors in which patent effectiveness and complementary assets importance are high, hence cooperation between new firms and incumbents is feasible.

Table 5.7. Commercialization environment – Sectors

Cooperative environment				Competitive environment			
Industry	ISIC number	Frequency	Percent	Industry	ISIC number	Frequency	Percent
R&D in biotech	7310	18	12.24	Software	7290	34	23.13
Pharmaceutical manufacture	2423	8	5.44	Business services & consulting	7414	23	15.65
Wholesale and retail trade	5122	5	3.40	Data processing/ computer consultancy	7230	13	8.84
General purpose machinery manufacture	2910	4	2.72	Architectural & engineering activities	7421	8	5.44
Food & beverages manufacture	1500	4	2.72	Other business activities	7499	2	1.36
Search navigation equipment manufacture	3314	3	2.04	Health services advice	8519	1	0.68
Miscellaneous chemicals manufacture	2429	3	2.04	Retail of textiles	5232	1	0.68
Textile manufacture	1700	3	2.04				
Semiconductors and related equipment	3211	2	1.36				
Motor/ generator manufacture	3110	2	1.36				
Plastic & rubber manufacture	2500	2	1.36				
Computer manufacture	3010	2	1.36				
Steel manufacture	2710	2	1.36				
Furniture manufacture	3600	1	0.68				
Aerospace manufacture	3530	1	0.68				
Medical equipment manufacture	3311	1	0.68				
Electrical equipment manufacture	3100	1	0.68				
Machine tools manufacture	2922	1	0.68				
Special purpose machinery manufacture	2920	1	0.68				
Metal products manufacture	2800	1	0.68				
Research in natural science	2429	1	0.68				
Total		66		Total		82	

Appendix 5.6.3: Additional analyses

Figure 5.4. Proportionality assumption test

Table 5.8. Effects of alternative measures of commercialization environment, founding teams' human capital and board on the likelihood of a new managerial hire

Figure 5.4. Proportionality assumption test: NVs with technological specialists teams

log-log plots

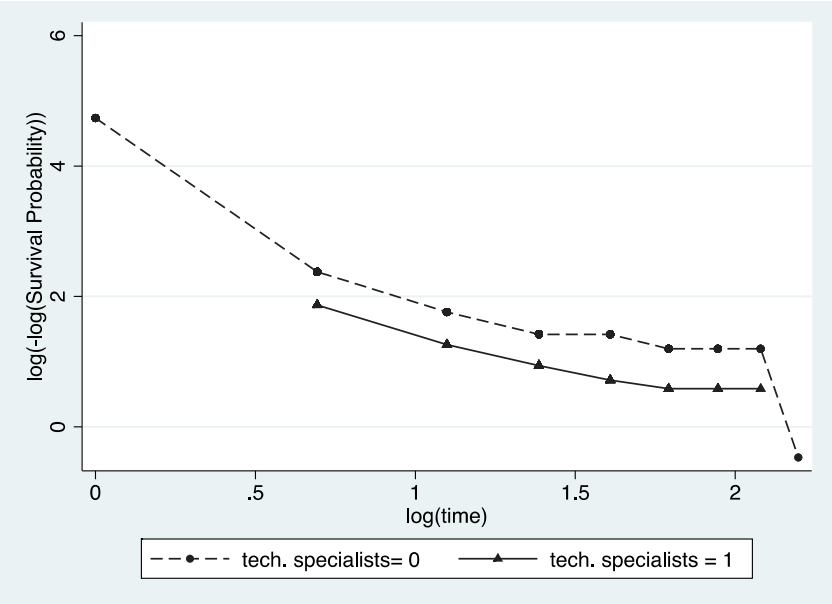


Figure 5.5. Proportionality assumption test: NVs that secured external investment

log-log plots

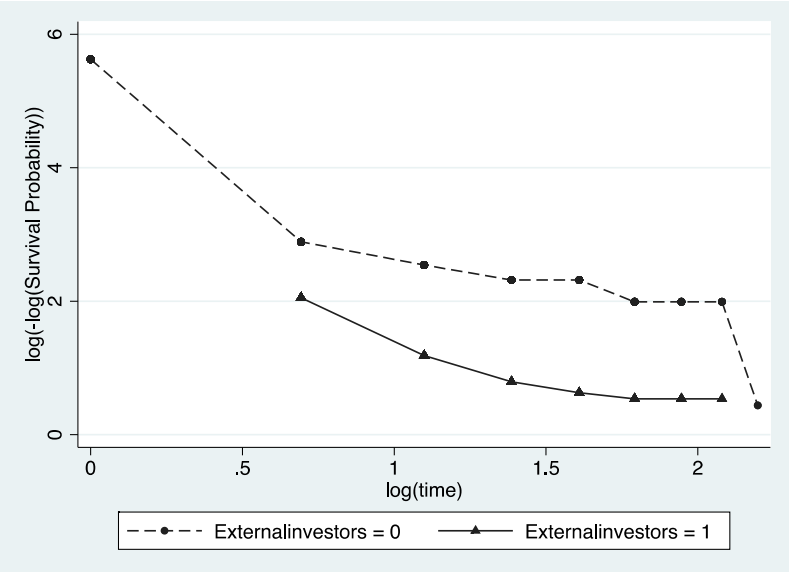


Table 5.8. Effects of alternative measures of commercialization environment

Cox proportional hazard model – Coefficients and robust standard errors a
Models 1-2: Continuous measure of cooperative commercialization environment (the higher the more cooperative)
Models 3-6: Sector proxies for commercialization environment (Software, Biotech)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
FT size (log)	.41	.45	.37	.51*	.45	.40
	(.27)	(.28)	(.28)	(.29)	(.27)	(.27)
Team exits	.80**	.82**	.98***	.88***	.80**	.99***
	(.33)	(.34)	(.33)	(.34)	(.34)	(.34)
Starting capital (log)	-.12	-.11	-.13	-.11	-.12	-.14
	(.09)	(.10)	(.09)	(.10)	(.09)	(.09)
Founding year: crisis	.31	.32	.27	.20	.28	.33
	(.30)	(.30)	(.31)	(.31)	(.30)	(.31)
Tech. specialists	.61**	.65**	.70**	.63**	.50*	.67**
	(.30)	(.32)	(.31)	(.32)	(.29)	(.31)
Start-up experience	1.51****	1.58****	1.28***	1.36****	1.51****	1.37****
	(.46)	(.45)	(.42)	(.41)	(.40)	(.40)
Board independence	1.27*	1.35**	1.13*	1.03	1.31*	1.30**
	(.68)	(.64)	(.61)	(.64)	(.68)	(.64)
External investment	.56	.58	.60*	.50	.54	.55
	(.44)	(.46)	(.41)	(.40)	(.43)	(.42)
Commercialization envir.	-.38**	-.53				
	(.17)	(.55)				
Software			.74**			.44
			(.32)			(.37)
Business Services				-.25		-.30
				(.34)		(.38)
Biomedical					-.75*	-.67
					(.43)	(.47)
Commercial environment X Tech. specialist		-.01				
		(.45)				
Commercial environment X Start-up experience		-.01				
		(.45)				
Commercial environment X Board independence		.01				
		(.62)				
Commercial environment X External investment		.34				
		(.55)				
Wald chi-square (degrees of freedom)	58.21***** (9)	57.36***** (13)	43.62***** (9)	39.77***** (9)	54.93***** (9)	50.34**** (11)

a Number of ventures is 148; number of new hires is 44; number of observations is 634

*p<0.10; ** p<0.05; *** p<0.01; **** p<0.001, two-tailed test

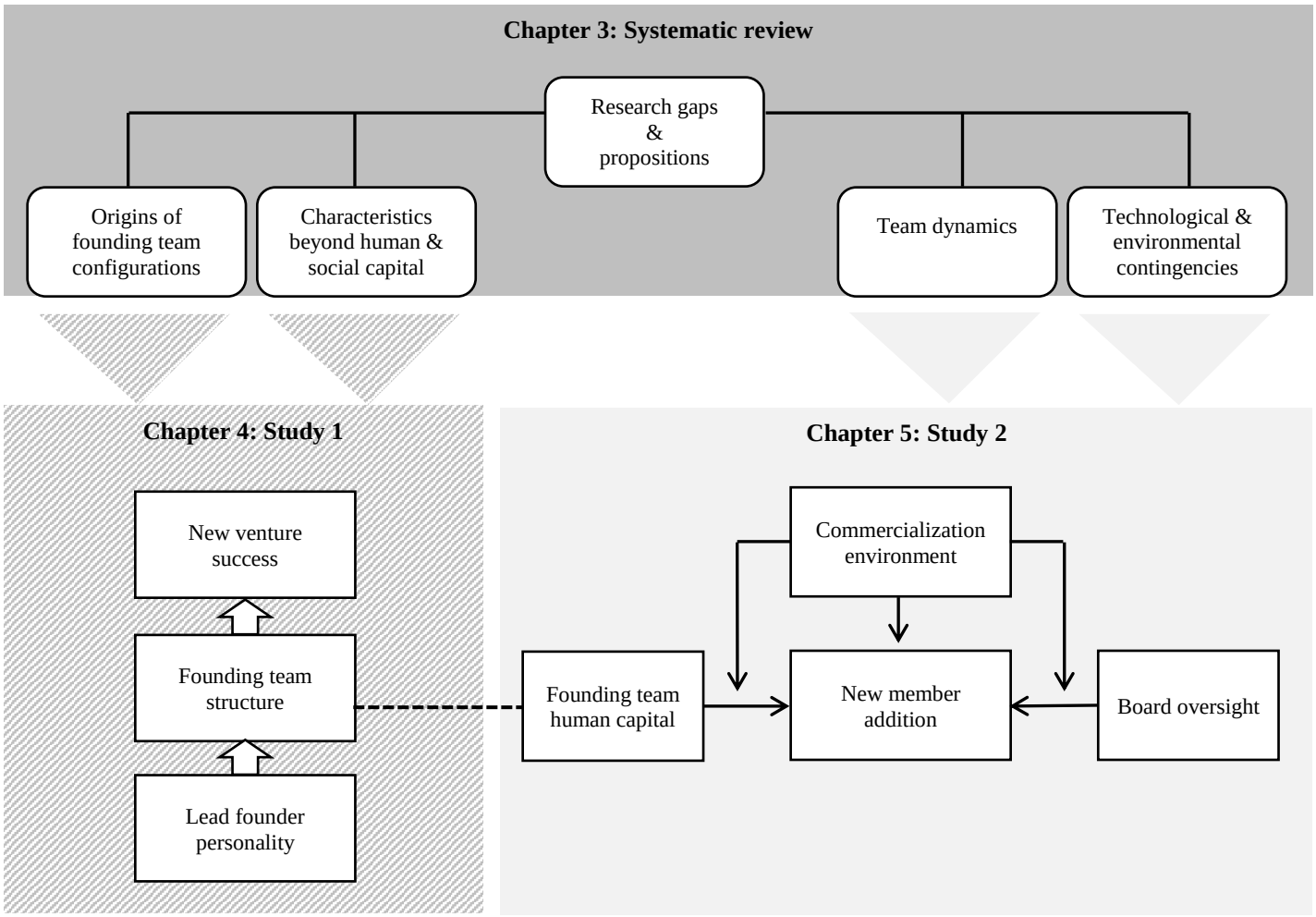
CHAPTER 6: CONCLUSION

The main goal of this PhD dissertation was to provide a deeper understanding of the role of the entrepreneurial team in technology-based new ventures. This is important because investors and entrepreneurs themselves perceive the quality of the team as one of the most critical determinants of entrepreneurial success. The importance of entrepreneurial teams is well-recognized within the academic community, yet only few studies have examined how these teams form and develop over time. The shortage of longitudinal studies on new venture teams may be due to the difficulty of collecting data on the demographics of all team members, including founders and managers joining the team at a later point of time. In this PhD dissertation, we collected an extensive amount of data about team members' career histories and demographics. Combined with the existing dataset of 169 Flemish technology-based start-ups, this effort resulted in a unique longitudinal database of 1,006 yearly observations (2006-2015) containing fine-grained information on individuals, teams, organizational characteristics and the external environment of nascent firms. This dataset enabled us to examine interesting hypotheses related to formation and evolution of entrepreneurial teams in technology-based sectors.

We first conducted a large systematic review of extant research (Chapter 3) in order to identify prominent gaps, which we later address in our two empirical studies (Chapter 4 – Chapter 5). The overall framework is illustrated in Figure 6.1. In particular, Chapter 3 summarizes and critically reviews existing literature on entrepreneurial teams in academic spin-offs. Chapter 4 aims to address the gap in research on team formation. It examines the origins of the founding team structure by investigating how a lead founder's personality traits may affect initial choices to form a team. Chapter 5 aims to contribute to the research on team evolution. It takes a multi-level approach to examine the antecedents of a first managerial hire and comparing their relative effects.

In the concluding chapter, we first present a summary of our key empirical findings. We then outline the main contributions of this doctoral thesis to the growing body of literature and discuss how our insights create a better understanding of the role of entrepreneurial teams in technology-based new ventures. Finally, we conclude by presenting the limitations of our work and discussing several directions for future research.

Figure 6.1. Overall framework of this dissertation



6.1. Summary of the main findings

Table 6.1 provides a short summary of the main outcomes of our systematic review presented in Chapter 3. After carefully reviewing and documenting the final dataset of 43 empirical

studies on entrepreneurial teams in academic start-ups, we mapped existing research according to the emerging common themes and identified prominent research gaps. Specifically, Chapter 3 shows that the extant research on teams in academic spin-offs tends to be (a) static in nature, (b) over-emphasizing the role of team members' human and social capital endowments, with (c) little focus on team functioning, (d) team formation and (e) environmental and technological fit. We formulated a number of open questions and called for more research on topics including founding team formation, compositional changes that occur within these teams over time, the role of technology and environment in team development and performance of the team, but also on the relations among the team members and the imprinting role of founders' personality, identity and ideology, which have been emphasized by related fields.

Table 6.2 summarizes the most important findings from the two empirical papers (Chapter 4 and Chapter 5) presented in this dissertation. In Chapter 4, we examined the role of lead founders' personality in initial choices with regard to the founding team structure. We found that personality traits that reflect individuals' interpersonal disposition – *extraversion, agreeableness* and *emotional stability* – are related to starting up with a team, as opposed to becoming a lone entrepreneur. *Conscientiousness* is reflected in an individual's deliberation and planning and is associated with the structural elaboration of the founding team. Interestingly, we found that these two types of personality traits predict different aspects of a founding team structure.

In Chapter 5, we examined the antecedents of a first manager-level hire in technology-based new ventures. We found that new ventures' likelihood to hire new managers is determined by multi-level forces – related to the *founding teams' human capital*, *board characteristics* and *new ventures' environment*. After carefully examining their relative importance, we found that external pressures applied by the board are the strongest predictors of a new managerial hire, followed by a founding team's prior start-up experience.

Surprisingly, the shortage of relevant commercial and managerial skills is the weakest predictor of a new hire in teams.

Table 6.1. Overview of the outcomes of the systematic review

	Chapter 3
Title	The role of teams in academic spin-offs
Focus	Entrepreneurial teams in academic spin-offs
Goal	Summarize and map existing research; identify the gaps and formulate future research propositions
Themes for future research advancement	• Attributes beyond human and social capital endowments • Team formation • Team evolution • Team functioning • Technological/ environmental contingency

Table 6.2. Overview of the two empirical papers

	Chapter 4	Chapter 5
Title	Micro-foundations of organizational blueprints: The role of lead founders' personality	Expanding the circle: antecedents of a new managerial hire in technology-based new ventures
Research focus	Founding team structure: Effects of lead founder's Big Five personality traits	Antecedents of the 1st new member addition
Theory	Person-organization fit theory; liabilities of newness hypothesis	Life-cycle theory; human capital; governance; contingency theory
Dependent variable	Founding by team; elaborate founding team structure; completion of organizational milestones	New member addition
Results	• Lead founders that score high on social disposition (extraversion, agreeableness, emotional stability) are more likely to start-up with a team, as opposed to being solo entrepreneurs • Lead founders that score high on conscientiousness are more likely to assemble structurally elaborated founding teams • Lead founders that score high on both interpersonal disposition and conscientiousness are more likely to assemble structurally elaborated founding teams	• NVs with technological specialist founding teams are more likely to hire new managers • NVs with prior start-up experience are more likely to hire new managers • NVs with board independence are more likely to hire new managers • NVs that generated external investment are more likely to hire new managers • NVs that operate in competitive commercialization environment are more likely to hire new managers

6.1.1. Synthesis of the findings

To gain a deeper understanding of the role of entrepreneurial teams, we first performed a literature review of empirical work on teams in science commercialization (Chapter 3), which enabled us to map existing work and to identify gaps and avenues for future research. We then used a unique longitudinal dataset of Flemish technology-based new ventures and their founding teams' career histories to address these research gaps in two empirical studies (Chapters 4 and 5). In this section, we aim to explicate the links between our findings in each of the papers of this doctoral dissertation.

Chapter 3, revealed a number of interesting research gaps. The most prominent gaps included the current lack of understanding of important topics such as (1) team formation, (2) team evolution, (3) team members' characteristics beyond human and social capital endowments and their role in shaping organizational goals, (4) team functioning, and (5) the role of technology and environment in the commercialization process. For the follow-up studies, we decided to focus our attention primarily on the gaps related to team formation and team evolution. We did so for several reasons. First, while our literature review focused specifically on teams within academic spin-offs, scholars within the broader research on entrepreneurial teams have pointed out the critical shortage of empirical work on team dynamics, which inevitably leads to an incomplete and even obscured picture of the role of entrepreneurial teams (e.g., DeTienne, 2010; DeTienne et al., 2012; Guenther et al., 2015). Second, the insight that team formation and membership changes are vital to fully understand team performance and its relation to organizational outcomes has been prevalent in the broader team literature, which calls for more dynamic approach towards team research (Mathieu et al., 2014). We therefore chose to focus on topic related to team dynamics – namely team formation and team evolution – the research gap prevalent in the literatures on teams in academic spin-

offs, but also general new venture teams and the broader team literature – in order to contribute to the overall understanding of the role of teams in organizational setting.

In Chapter 4, we address research questions related to team formation by examining how lead founders' personality traits may influence their preferences towards a certain founding team structure. Beyond the main findings of this chapter, which are presented in the preceding section, we also inspected our sample for the overlaps between the insights stemming from our literature review (Chapter 3) and the follow-up chapter on team evolution (Chapter 5). The dataset used in this chapter comprised both, university spin-offs and independent firms. In line with prior research summarized in the literature review on academic spin-offs, academic spin-offs in our sample were more likely to form larger founding teams. Also, consistent with previous findings, being a spin-off had no effect on founding team structure – neither in terms of experience nor formalized roles (Colombo & Piva, 2012). Unfortunately, the number of university spin-offs was too small to perform sub-analyzes of our predictors on this group. Hence, we were not able to tell whether the academic entrepreneurs are likely to differ from other entrepreneurs with regard to their personality characteristics.

The finding that lead founders' personality may predispose ventures to a certain founding mode is very intriguing, as due to the path-dependency forces it may constrain ventures' future development. In this chapter, we briefly discuss path-dependency as a mechanism through which founding team structure may affect new ventures' subsequent development and success over time. Yet, we did not empirically test it. In the subsequent chapter, when examining the evolution of founding teams, we had an opportunity to examine some of the indicators of potential constraints by founding team structure.

In Chapter 5, we aimed to contribute to the research on team evolution by examining the antecedents of a first managerial hire to founding teams. Beyond the main findings of this chapter, presented in the earlier sections, we have examined the links between this study and

the other two papers. The most intriguing link between the first and the second empirical paper, would be to see whether the founding team mode may constrain teams' subsequent professionalization. Although, our data did not allow us to fully explore the imprinting effects of founding team structure, we did examine the effects of each of each of its elements on new ventures' likelihood to hire a new manager. For instance, we examined whether a team-based founding mode has an effect on the subsequent managerial hire. We found that new ventures started by a solo entrepreneur are less likely to add new managers at a later point of time. This is an intriguing finding, as one would expect new ventures with limited team size to be more prone to enlarge its human capital pool by hiring an additional member. This finding is inconsistent with the human capital enlargement hypothesis, which was otherwise confirmed when looking at the overall experience of the team – whereby teams with only technological experience were more likely to hire new managers. As we found that founders who score lower on interpersonal disposition traits (extraversion, agreeableness and emotional stability) are more likely to become solo-entrepreneurs, this finding could be attributed to the personality of these individuals. It could be, for instance, that this type of people are less comfortable with sharing responsibility and giving up control over their venture. As the insight is limited in its statistical validity, this is something that could be examined in more depth by future research.

We also looked at the effects of elaborate founding team structure on the likelihood of a new managerial hire, but found no effect. We also examined the effects of lead founders' personality on new ventures' likelihood to hire new manager. However, due to the distal nature of outcome (of new hire), we found neither theoretical nor empirical support for this proposition. We also examined whether academic spin-offs are more likely than their independent counterparts to hire new managers. We found some significant relation between a spin-off and a new hire if we did not control for external investment and external board. However, since majority of academic spin-offs receive external investment and have large

external boards, this effect disappeared as soon as external investment and external funding were introduced in the model. In sum, we have looked into the potential constraints of founding team structure and we find some – although limited – evidence that such constraints may take place.

6.1.2. Performance effects

Due to data limitation, we could not provide a detailed account of the performance effects of founding team structures, nor of their professionalization. Although, this is the main limitation of this doctoral dissertation, in this section we aim to provide some indications about the effects founding team structure has on new venture success. We do so only for the effects of founding teams structure, as our data does not allow us to examine performance effects of new managerial hires.

The main challenge within the entrepreneurship research is to find a good performance measure that would allow to compare start-ups across different sectors. In this section, we define new venture performance as completion of an important organizational milestones: acquisition of venture capital. This performance measure represents one of new ventures' most critical junctions (Shane & Stuart, 2002), particularly during the time of the focus of our study, namely within the first years after new venture's incorporation. Our focus is on time to the first VC fund, rather than the total generated amount, because subsequent rounds of funding are more associated with investors' direct knowledge about the firm, while the amount is predominantly firm and sector-specific (Gompers & Lerner, 1999). Focusing on the first round of VC allows us to examine what founding team structures enable firms to obtain VC funds and if they do, which structures allow them to obtain funds more quickly than others. Another advantage of using this type of measure is that it allows us to compare the performance of entrepreneurial firms across multiple sectors. This task is otherwise difficult when using

accounting-based measures of profitability, as the product development cycle and time to first sales differs enormously by sector.

Methods. We collected data about VC funds from the interviews with the ventures. This information was verified using web search, including firms' websites, venture capital platforms, and press releases. We were able to obtain and verify this information from 132 firms out of our sample (of 169 firms). We make use of the panel data structure and record whether a firm has raised venture capital on the yearly basis. Our final sample with which we test the effects of founding team structure on VC acquisition includes 132 firms, with 665 observations (spells). We code a dummy variable with values 1 if the firm has obtained VC, and value 0 for otherwise and conduct event-history analysis to examine this outcome. Of our 132 firms at risk of VC funds, 15 (11%) have obtained venture capital. This number seems low, yet it is consistent with the fact that VC funding in continental Europe is rather rare. Table 6.3 provides an overview of the methods, including the summary of the key variables and the sample size.

Table 6.3. Methods overview: Variables, analysis, sample size

	Dependent variable	Predictors	Controls	Analysis	N
Panel data *(Subsample of firms)*	Venture capital (1/0)	FT vs. solo (1/0) FT size FT elaborate structure	Founding year (crisis) Product University spin-off LF commercial experience	Cox proportional hazard	Firms=132 Observations= 665 Events= 15

Results. Table 6.4 presents descriptive statistics. Table 6.5 and Table 6.6 present the results (coefficients and robust standard errors) of our Cox proportionate hazard models examining the effects of founding team structure on new venture success – namely VC acquisition. Due to the low number of predicted events of VC acquisition, we were very careful when adding the control variables, so as not to overfit the model.

Table 6.5 shows the effects of founding by team on venture capital acquisition. Model 1 is the baseline model showing the effects of our control variables. The year of founding and founding as a university spin-off are positively related to VC acquisition. Models 2 to 7 show the effects of founding by team while individually adding each of the control variables. Models 8 to 18 show the effects of our predictor with several combinations of control variables. The coefficients of founding by team are weakly significant across all the models ($p < 0.1$, two-tailed test). Hence, we find weak support for the positive effects of team-based founding on new ventures' success.

Table 6.6 shows the effects of the founding team's elaborate structure on the propensity of new ventures to obtain VC funds. The tests were performed on a subset of firms founded by teams, as elaborate team structure is conditional on starting up with a team. Model 1 is the baseline model showing the effects of our control variables. Models 2 to 7 show the effects of founding by team while individually adding each of the control variables. The coefficients of founding team elaborate structure are positive and significant across all models ($p < 0.01$, two-tailed test). Models 8 to 18 show the effects of our predictor with several combinations of control variables. The coefficients are positive and significant throughout most of these models. We thus, find support that a founding team's elaborate structure has a positive effect on new venture's completion of critical milestones.

Table 6.4. Variable descriptive statistics

Variable	Mean	Std. Dev.	Min	Max
1. VC	.11	.32	0	1
2. FT elaborate structure	.06	.88	-1.35	2.68
3. FT size (log)	.68	50	0	1.95
4. FT 01				
5 Team entry				
6. Product	.76	.43	0	1
7. University spin-off	.28	.45	0	1
8. LF commercial experience	3.26	5.54	0	25

N firms =132; N spells 665

	1	2	3	4	5	6
1. VC	1.00					
2. FT elaborate structure	.24*	1.00				
3. FT size	.23*	.64*	1.00			
4. FT 01						
5 Team entry						
4. Product	.07	.13*	.09	1.00		
5. University spin-off	.27*	.07	.23*	-.04	1.00	
6. LF commercial experience	.00	.17*	-.09	-.02	-.12*	1.00

Table 6.5. Effects of team-based founding on the likelihood of VC acquisition

Cox proportional hazard model – Coefficients and robust standard errors

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6 [a]	Model 7
Founding year:							
crisis	1.23***	1.37***					
	(.47)	(.49)					
University spin-off	1.44***		1.27**				
	(.49)		(.55)				
Product				.13			
				(.63)			
LF prior commercial exper.					.04		
					(.06)		
FT prior commercial exper.						.08	
						(.06)	
Team entry							-.77
							(1.02)
Founding by team (0/1)		1.91*	1.47	1.82*	1.91*	1.98*	1.84*
		(1.05)	(1.07)	(1.03)	(1.08)	(1.12)	(1.03)
Log pseudolikelihood-ratio	-65.63	-66.46	-66.89	-69.78	-69.48	-67.14	-69.30
Wald chi-square	18.08***	8.69**	14.33****	3.39	3.11	3.51	3.98
(degrees of freedom)	2	2	2	2	2	2	2

	Model 8	Model 9	Model 10	Model 11 [a]	Model 12	Model 13	Model 14
Founding year:							
crisis	1.26***	1.37***	1.45***	1.33***	1.35***	1.45***	1.41***
	(.48)	(.49)	(.52)	(.51)	(.50)	(.52)	(.54)
University spin-off	1.17**						1.27**
	(.54)						(.57)
Product		.17				.13	.26
		(.62)				(.64)	(.67)
LF prior commercial exper.			.06			.06	.07
			(.05)			(.05)	(.06)
FT prior commercial exper.				.08			
				(.05)			
Team entry					-.76		
					(.97)		
Founding by team (0/1)	1.54	1.91*	2.15*	2.24*	1.94*	2.15*	1.78
	(1.13)	(1.05)	(1.25)	(1.27)	(1.06)	(1.25)	(1.32)
Log pseudolikelihood-ratio	-64.02	-66.42	-65.84	-63.99	-66.02	-65.82	-63.05
Wald chi-square	22.56****	8.65**	7.97**	8.22**	9.93**	8.01*	18.65***
(degrees of freedom)	3	3	3	3	3	4	5

	Model 15	Model 16 [a]	Model 17 [a]	Model 18 [a]
Founding year:				
crisis	1.42***	1.34***	1.33***	1.34***
	(.52)	(.51)	(.52)	(.52)
University spin-off			1.24**	
			(.56)	
Product	.21	.33	.34	.41
	(.64)	(.64)	(.64)	(.65)
LF prior commercial exper.	.06			
	(.06)			
FT prior commercial exper.		.08	.10*	.08
		(.05)	(.05)	(.05)
Team entry	-.86			-.88
	(.99)			(.98)
Founding by team (0/1)	2.21*	2.27*	1.88	2.33*
	(1.25)	(1.28)	(1.38)	(1.28)
Log pseudolikelihood-ratio	-65.30	-63.86	-61.22	-63.41
Wald chi-square	9.62*	8.44*	15.92***	10.10*
(degrees of freedom)	5	4	5	5

N firms= 132; N events=14; N spells= 537

**p<0.10; **p<0.05; ***p<0.01*, two-tail test

[a] *N firms= 125; N events=15; N spells= 458*

Table 6.6. Effects of elaborate team structure on the likelihood of VC acquisition

Cox proportional hazard model – Coefficients and robust standard errors

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6 [b]	Model 7
Founding year:							
crisis	1.46***	1.38**					
	(.50)	(.57)					
University spin-off	.94*		1.14**				
	(.50)		(.50)				
Product				-.19			
				(.64)			
LF prior commercial exper.					.03		
					(.06)		
FT prior commercial exper.						.07	
						(.06)	
Team entry							-.85
							(1.12)
FT size (log)							
FT elaborate structure		.47**	.68***	.68***	.62***	.50**	.69**
		(.23)	(.20)	(.25)	(.24)	(.25)	(.27)
Log pseudolikelihood-ratio	-56.96	-57.16	-57.93	-60.12	-.59.94	-58.21	-59.62
Wald chi-square	14.72****	22.20****	23.47****	7.61**	7.30**	7.90**	6.68**
(degrees of freedom)	2	2	2	2	2	2	2

	Model 8	Model 9	Model 10	Model 11	Model 12	Model 13 [b]	Model 14
Founding year:							
crisis		1.41***					
		(.54)					
University spin-off			1.14**				
			(.50)				
Product				.81			
				(.66)			
LF prior commercial exper.					.03		
					(.06)		
FT prior commercial exper.						.07	
						(.06)	
Team entry							-.86
							(1.12)
FT size (log)	-.49	-.63	-.41	-.37	-.34	-.07	-.41
	(.89)	(.97)	(.89)	(.92)	(.92)	(.92)	(.87)
FT elaborate structure	.74**	.57*	.74****	.74**	.69**	.51	.77**
	(.32)	(.32)	(.26)	(.32)	(.33)	(.36)	(.35)
Log pseudolikelihood-ratio	-60.06	-56.95	-.57.83	-60.03	-59.87	-58.20	-59.51
Wald chi-square	7.60**	21.73****	25.12****	7.52*	7.21*	7.89**	6.56*
(degrees of freedom)	2	3	3	3	3	3	3

	Model 15	Model 16	Model 17 [b]	Model 18 [b]
Founding year:				
crisis	1.49**	1.58***	1.46**	1.48**
	(.62)	(.60)	(.62)	(.60)
University spin-off	1.11**	1.16**	1.06**	1.07**
	(.55)	(.55)	(.51)	(.50)
Product	.01	.13	.15	.18
	(.69)	(.77)	(.69)	(.74)
LF prior commercial exper.	.08	.08		
	(.05)	(.05)		
FT prior commercial exper.			.11**	.10*
			(.05)	(.06)
Team entry				
FT size (log)		-.80		-.28
		(1.05)		(1.07)
FT elaborate structure	.41*	.52*	.25	.29
	(.21)	(.29)	(.25)	(.35)
Log pseudolikelihood-ratio	-54.44	-54.15	-53.13	-53.10
Wald chi-square	37.63****	41.04****	35.22****	41.37****
(degrees of freedom)	5	6	5	6

Subsample of ventures founded by teams: N firms= 91; N events=14; N spells= 458
**p<0.10; **p<0.05; ***p<0.01,* two-tail test

[b] *N firms= 86; N events=14; N spells= 369*

Robustness analyses. We also performed supplementary analyses in which we added a number of additional control variables, including the exact founding years, sector, starting capital, and lead founder's prior experience. The results remained unchanged. Additionally, we performed analyses using the sub-scales of the elaborate founding team structure construct, namely the founding team's breadth of roles and the founding team's breadth of experience. The results are presented in Table 6.7. While a number of our analyses shows significant effects of both breadth of roles and experience, they clearly show that the effects of role breadth are stronger than those of the experience. These indicate that the structure is particularly important for new the long-term development and success of new ventures. We also performed additional analyses of the effects of elaborate founding team structure, as well as the subscales thereof, on new ventures' completion of organizational milestones, in a sub-sample of team-based new

ventures. Our results remained unchanged. We also examined whether the lead founder's personality directly affects the new venture's completion of organizational milestones and found no significant direct effect. In summary, these supplementary analyses indicate that our findings are generally robust across various model specifications and variable operationalizations.

Table 6.7. Effects of founding team breadth of roles and experience on VC acquisition

Cox proportional hazard model – Coefficients and robust standard errors

	Panel 1: VC [c]			Panel 2: VC [d]			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Founding year:							
crisis	1.275***	1.176**	1.218**	1.704***	1.495**	1.556***	1.688***
	(.48)	(.50)	(.50)	(.56)	(.62)	(.57)	(.62)
Product	.170	-.192	.206	.180	.012	-.214	.182
	(.67)	(.67)	(.69)	(.68)	(.69)	(.67)	(.69)
University spin-off	1.579***	1.300**	1.578***	1.056**	1.114**	1.006*	1.06**
	(.56)	(.55)	(.55)	(.54)	(.55)	(.53)	(.52)
Prior commercial exper.	.048	.047	.049	.095*	.079	.084*	.093
	(.05)	(.05)	(.05)	(.05)	(.05)	(.05)	(.06)
FT elaborate structure					.414*		
					(.22)		
FT roles breadth		.768****				.667***	
		(.24)				(.24)	
FT experience breadth			.242				.031
			(.22)				(.26)
Likelihood-ratio	-65.073	-64.496	-65.237	-55.424	-54.437	-53.069	-55.418
Wald chi-square	15.91***	37.00*****	32.09*****	11.66**	37.63*****	28.33*****	15.89***
(degrees of freedom)	4	5	5	4	5	5	5

[c] *N subjects= 132; N events=15; N spells= 665*

[d] *N subjects= 91; N events=14; N spells= 458*

**p<0.10; **p<0.05; ***p<0.01,* two-tail test

6.2. Contributions to existing literature

The three chapters of this PhD dissertation aimed to extend our understanding of the evolution of entrepreneurial teams and have contributed to the corresponding literatures in a number of ways. In this section, we elaborate on the key contributions to the existing research (note that the specific contributions are listed in each of the separate chapters).

After performing a careful review of the existing work, we identified a major gap within the research on entrepreneurial teams, namely – existing research tends to be predominantly static with the vast majority of studies focusing on the performance effects of team characteristics but disregarding compositional and relational changes occurring in these teams. Topics of team formation and team evolution within the large stream of team research are scarce (for exceptions, see Silicon Valley studies of Beckman & Burton, 2008; Beckman et al., 2007; Ferguson et al., 2015), despite the evidence that entrepreneurial teams continuously change in their composition as founders exit (DeTienne, 2010; DeTienne et al., 2012; Guenther et al., 2015) and new members enter the team (Brinckmann & Högl, 2011; Chandler & Lyon, 2009; Ferguson et al., 2016). The lack of longitudinal approach to teams is not only limited to the entrepreneurship research, but to the broader team literature, which has called for more studies taking into an account the dynamic nature of team composition (Mathieu et al., 2014). The main contribution of this PhD dissertation to team research in general and to new venture research in particular, is that it is specifically dedicated to issues relevant for team formation and evolution. With the main focus on the founding team development, this dissertation explored several important and interrelated questions addressing why management teams look the way they do and how they change over time. Specifically, the two empirical chapters addressed following questions: (a) why some new ventures start up with more while others with less developed founding teams (Chapter 4) and (b) when do founding teams professionalize (Chapter 5)?

To examine these questions, the present PhD thesis took an interdisciplinary approach, combining insights from social and organizational psychology, personality research, management, entrepreneurship, and governance. Combining insights from different yet interrelated disciplines, allowed us to study the phenomenon of entrepreneurial team evolution from a number of angles, providing a more wide-ranging view on the topic. Addressing the issue form an environmental, organizational, team-based and individual angles requires very extensive data that captures adequately team and firm-level developments over time. One of the main reasons why longitudinal research on entrepreneurial teams is scarce, is because this type of data is not readily available and is difficult to collect. As a result, the majority of studies on entrepreneurial teams rely on cross-sectional datasets (Klotz et al., 2014; Nikiforou et al., 2018). We developed a unique dataset that enables us to have a deeper insight into the organizational, team and individual attributes of technology-based new ventures – with the longitudinal design allowing us to follow changes within these attributes over time. The development of this dataset is the second main contribution of this PhD dissertation.

For instance, the detailed accounts of individuals and teams enabled us to examine the antecedents of founding team design. Chapter 4 examined whether the variation of founding team structure could be traced to the lead founders' individual differences. Prior studies have suggested that individuals' values and norms explain diversity within new ventures' initial organizational structures (Baron & Hannan, 2002; Leung et al., 2014). Yet research on founding team structures has acknowledged the role of the individual founder but did not empirically test it. Prior studies have largely focused on the institutional (Colombo & Piva, 2012; Ensley et al., 2005) and sociological (Aldrich & Kim, 2007; Forbes et al., 2006; Ruef et al., 2003) mechanisms guiding founding team formation. Chapter 4 is the first quantitative study to examine the role of lead founders' disposition in setting up a founding team. We found that an individual' personality reflects the preference of *whether* to and *how* to assemble a

founding team. By doing so, we show that individuals' personality is important in early decisions of the founders and contribute to the ongoing research on founding conditions. To further extend this stream of research, it would be interesting to examine whether the effects of lead founders' personality have long-lasting effects on new venture development and success. In other words, it would be interesting to examine whether lead founders' personality may imprint their venture.

Having access to the longitudinal organizational information and the yearly updates about the team enabled us to investigate compositional changes within teams. For instance, Chapter 5 integrated and extended existing insights on new member addition. Prior studies have predominantly examined the issue form a single perspective focusing either on the team, organization or environment and often relied on a cross-sectional dataset, comprising various industries, not restricted to the technological domains (e.g., Brinckman & Hoegl, 2011; Chandler et al., 2005; Ucbasaran et al., 2003). Our rich longitudinal dataset allowed for a more fine-grained examination of the new venture attributes that affect team evolution on different levels of analysis. It also allowed us to examine the relative importance of these attributes.

Another important contribution of this PhD dissertation lies in its multi-level approach. The present work has demonstrated that examining issues relevant for teams from various angles using different levels of analysis helps to generate more nuanced insights. For instance, our Chapter 5 shows that team development is affected by forces operating on different levels of analysis – including teams' initial competences, but also organizational and environmental characteristics. Prior studies have also addressed the importance of multi-level factors in compositional change by examining the effects of team attributes and either the organizational or the environmental characteristics (e.g., Boeker & Wiltbank, 2005; Chandler et al., 2005). However, these studies were not able to produce detailed insights into the antecedents of a new member addition at all three levels of analysis, nor into the relative effects of these antecedents.

While Chapter 5 showed that macro-level factors may be strong predictors of micro-level outcomes, Chapter 4 shows that micro-level forces affect higher-level outcomes. This study has demonstrated that lead entrepreneurs' disposition is an important predictor of founding team structure. Having highlighted the multi-faceted nature of founding team development, we contribute to the stream of research in entrepreneurship and management that adopts multilevel approach (e.g., Baum & Locke, 2004; Baum et al., 2001; Hitt et al., 2007).

6.3. Limitations and future research

Despite the various contributions, this PhD dissertation also has several limitations that provide opportunities for future research. These limitations refer predominantly to the boundaries of the scope of this dissertation. With the goal to extend the current understanding of the evolution of entrepreneurial teams, we focused on the antecedents of founding team formation and professionalization. By doing so, we address important gaps within the existing research on entrepreneurial teams, which include (1) an insufficient understanding of the origins of and the heterogeneity among the founding teams, and (2) a lack of research on compositional changes within entrepreneurial teams. However, other relevant topics, including research gaps identified in our systematic review were not addressed within the scope of this work.

First, the most apparent limitation of this PhD dissertation is that it did not examine new venture performance. While we have presented some indications that the founding mode with a more elaborately structured founding team positively affects completion of critical organizational milestones (VC acquisition), we did not sufficiently investigate this effect. Therefore, this finding should be treated only as an indication in support of findings of previous studies. We also have not investigated whether the professionalization of the founding team necessarily leads to a better performance (Chapter 5). Although the question of performance is certainly one of the key questions in entrepreneurship research, it also poses the key challenge

with regard to its operationalization. For instance, it is not clear how to define performance in firms that do not generate revenues and where financial information is either not available or non-existing. Another issue related to performance of entrepreneurial firms relates to the comparability of start-ups – as even within the same sector, new ventures may differ with regard to their cost-intensity and their product-to-market cycle. Addressing these challenges deserves a PhD on its own.

Second, responding to the calls for more dynamic research (Klotz et al., 2014; Mathieu et al., 2014), we have examined antecedents of team formation and compositional change. With the primary focus on the origins of team composition at different points of time, we did not examine the changing effects of team characteristics across different stages of new venture development. There is evidence that some team attributes may be more prominent in the early stages of firm development but lose their importance over time (Brixy, Sternberg, & Stüber, 2012; Klotz et al., 2014). For instance, prior start-up experience may help to build a customer base and reach external investors in the early stages of new venture creation, yet become less important over the course of time, as it becomes less and less applicable to the new firm (Gruber et al., 2008). This is a common limitation across extant entrepreneurship research and beyond, as we have highlighted in our systematic review (Chapter 3).

Third, while we highlighted the role of individuals and the compositional characteristics of the teams they form, we did not look into the relational attributes of the team. Organizational outcomes may be traced back to the degree to which the team makes use of its available knowledge – therefore mechanisms relating to the team functioning, such as knowledge-sharing (Austin, 2003; Rulke & Rau, 2000), behavioral integration (Hambrick, 1994; Lubatkin, Simsek, Ling, & Veiga, 2006), and conflict (Bradley, Klotz, Postlethwaite, & Brown, 2013; De Wit, Greer & Jehn, 2012) may play a vital role. Examining the role of team functioning however requires subjective team-based information, which we were not able to collect within

the scope of this dissertation. Future research could examine in how far the inter-relational mechanisms within teams play role in strategic decision-making.

Another limitation of this PhD dissertation relates to what we define as the new venture age throughout our empirical studies. We followed new ventures after their legal founding, whereby we defined new venture age as zero at the time of its legal incorporation. However, it needs to be noted that some ventures may take up to several years before their official launch. This is typically the case with the new firms originating from research institutes, which may provide a longer incubation period in which they supply new ventures with all relevant resources until all important elements are at place (Clarysse & Moray, 2004; Vanaelst et al., 2006; Volhora et al., 2004; Rasmussen et al., 2011). In some cases, this pre-founding stage, including idea generation, opportunity framing, and pre-organization, may take up to 15 years (Rasmussen et al., 2011). While we have controlled for university spin-offs in our analyses and robustness checks, we do not have the information about how much support and what kind of support each of these ventures received during their incubation phase. Future research should look into these issues in more detail. Furthermore, research into the team formation indicates that the compositional change within teams during the pre-founding stage are not uncommon (Clarysse & Morray, 2004; Vanaelst et al., 2006). This stream of research is mainly qualitative (e.g., Clarysse & Moray, 2004; Vanaelst et al., 2006; Rasmussen et al., 2011; Vohora et al., 2004) and therefore based on a limited number of cases. Future research may benefit from examining quantitatively issues related to team evolution during the pre- and post-founding stages. More specifically, future research could examine how teams come together to frame an opportunity and what composition with regard to team members' knowledge and experience influences opportunity identification as well as new venture's ability to pivot over time.

6.4. Practical implications

In this dissertation we discussed topics related to management structures in nascent entrepreneurial firms. Next to contributing to theoretical and empirical insights, our findings may also inform practitioners – including investors, policy-makers and entrepreneurs.

First, the present work shows that entrepreneurial teams – and more specifically founding teams – clearly matter. Our systematic review (Chapter 3) has highlighted the role of these teams in several ways. For instance, based on the insights generated by prior research we proposed that human and social capital of founders enables firms to achieve organizational goals and is a strong predictor of new venture performance. At the same time, founders' personality, identities and ideology have a profound effect on new firm creation. They determine what values entrepreneurs pursue and whether they aspire growth. Finally, relational characteristics within teams – including the degree of trust, cohesion, and team satisfaction – may enhance the way team members combine their efforts to achieve organizational goals. Cohesive teams with a broad set of industry-relevant knowledge, that they actively share among all members of the group, are known to have higher team effectiveness, which is likely to translate into higher organizational performance. Policy makers and investors may use these insights to identify high potential new ventures based on the quality of the team and the relations between the individual team members. Investors may consider coaching teams towards cooperative and effective groupwork. Also, entrepreneurs should consider carefully these insights when making decisions about whether and how to form a team.

Second, our Chapter 4 highlighted the important role of the lead entrepreneur in setting the first and foremost important structure of the nascent new venture – the structure of its founding team. Acknowledging that an individual's personality may lead to biases towards a certain type of team design is important to be able to overcome them. For instance, external stakeholders that take an active part in shaping and enabling new ventures could instruct

founders about the benefits of formally differentiated structures. They could further provide mentorship and coaching to recognize biases caused by personality and create heuristics to help work around them. It needs to be noted that one's personality cannot be changed, but one can train certain aspects of managerial competences to enable handling of managerial tasks in a more effective way. These biases caused by personality types may fall under the common pitfalls of the founder's dilemmas – early decisions made about the founding team that can either enable or damage a start-up and its team, whereby the easy short-term decisions are often the most dangerous in the long term (Wasserman, 2012). Entrepreneurs should develop an increased awareness of these biases in order to be able to navigate around them and to be prepared to avoid the common pitfalls.

Another contribution that the Chapter 4 offers to founders and investors is that it highlights and provides some support to the growing body of evidence suggesting that new ventures with more developed founding teams tend to be more successful in the entrepreneurial process. Based on this evidence, founders should bear in mind that their initial choice of the founding team structure may affect their venture performance in a long run. We have proposed a construct of an elaborate team structure – to describe a founding team that comprises both the broad set of formally-defined functional roles, and the broad set of experiences that enables individuals to fulfil these roles. This construct may serve as a lens through which investors can evaluate the quality of the team, as it suggests an approach to identify formally-developed team structures that promote successful blueprint of a nascent firm.

Fourth, our Chapter 5 highlighted a number of factors that influence the professionalization of the management team. We found that significant factors include characteristics inherent to the organization (such as founding team and new venture's external environment) that cannot be readily changed. Therefore, it is particularly important to consider their long-term effects before formally launching a venture. For instance, experiences of the

founding team seem to have a long-lasting effect, whereby the professionalization process may be hindered due to the lack of the relevant social capital needed to recruit a suitable candidate. When forming a team, founders should bear in mind that they will have to recruit a new team member at some point of time. They should therefore critically assess the human and the social capital of their initial team to ensure that they have the relevant network from which they could potentially select a new member.

Similarly, the findings of the Chapter 5 suggest that when forming a team, founders should consider carefully the type of environment they wish to commercialize their products or services in, as the environment has a direct implication for the requirements to the management team. If a firm wishes to enter an environment that favors a highly competitive commercialization strategy, the founding team should anticipate the strong need to hire new managers to maintain competitive advantage on the market. Hence, founders should be prepared that the new hires might be required soon after the new venture launched.

To conclude, the findings of this dissertation highlight the importance of founding conditions for the formation and the development of a new venture in technology-based sectors. As these initial choices may have long-lasting effects, they have to be treated with caution by entrepreneurs and investors.

6.5. Epilogue

To conclude, we hope that the systematic review and the two empirical studies that form the basis of this PhD dissertation make a valuable contribution to the understanding of entrepreneurial teams – their formation and evolution. We also hope that this dissertation was able to set the stage for future research on topics related to entrepreneurial teams that could advance both theory and practice.

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NEDERLANDSE SAMENVATTING

Deze doctoraatsthesis bestaat uit drie empirische studies (Hoofdstukken 3-5) in het domein van ondernemingsteams in hoogtechnologische start-ups.

Hoofdstuk 3: De rol van teams in academische spin-offs

Academische spin-offs (ASO's) vertegenwoordigen een klein maar economisch significant aandeel van hightech nieuwe ondernemingen. Afkomstig uit een historisch niet-commerciële omgeving, worden deze nieuwe ondernemingen geconfronteerd met uitdagingen, waarvan de kern de noodzaak is om synergie te creëren tussen technologische en zakelijke competenties om nieuwe en potentieel disruptieve technologieën succesvol te commercialiseren (Rasmussen, Mosey, & Wright, 2011). Deze uitdagingen kunnen een mogelijk gebrek aan relevante commerciële vaardigheden en ervaring in de sector inhouden, evenals de noodzaak om nieuwe managers in te huren in een poging om deze tekortkoming te verhelpen. Nieuwe professionals kunnen relevante managementkennis toevoegen, maar deze toevoegingen kunnen ook nadelig zijn, omdat verschillen tussen managers en ingenieurs met betrekking tot hun denkwijze en identiteiten mogelijk groot zijn.

Het doel van hoofdstuk 3 van dit proefschrift is om de bestaande literatuur over teams in ASO's op systematische wijze te herzien om een overzicht van pertinente gemeenschappelijke thema's mogelijk zouden maken, en om lacunes in onderzoek te identificeren. We zien dat het merendeel van de studies zich richtte op human capital (HC) en sociaal kapitaal (SC) van academici en surrogaatondernemers die het ASO-team vormden, terwijl er veel minder aandacht was voor kwesties rond teamvorming en -evolutie. Slechts een handvol onderzoeken richtte zich op kwesties ten aanzien van het functioneren van teams, zoals kennisuitwisseling en conflicten. Op basis van deze kritische beoordeling van de status-quo hebben we verschillende lacunes in het onderzoek geïdentificeerd en veelbelovende

mogelijkheden voor toekomstig onderzoek uitgewerkt. We willen een aantal van deze hiaten adresseren in de volgende hoofdstukken van dit proefschrift.

Hoofdstuk 4: Microfundamenten van organisatorische blauwdrukken: de rol van de persoonlijkheid van de oprichter

Founding team-structuren zijn van cruciaal belang gebleken voor de ontwikkeling en het succes van nieuwe ondernemingen, omdat ze een raamwerk bieden voor ondernemers om hun inspanningen te combineren en te kanaliseren om organisatiedoelstellingen te bereiken, maar ook omdat ze na hun oprichting vaak langdurig en moeilijk te veranderen zijn (Beckman & Burton, 2008; Leung et al., 2013). Wetenschappers meldden bijvoorbeeld dat nieuwe ondernemingen die door teams zijn opgericht, in tegenstelling tot alleenstaande ondernemers, hogere overlevingspercentages hebben (Aspelund, Berg-Utby en Skjevdal, 2005), en dat het oprichten van teams met hogere niveaus van structurering meer kans geeft om te groeien (Sine et al., 2006), risicokapitaal verkrijgen (Beckman & Burton, 2008), en een beursintroductie te bewerkstelligen (Beckman et al., 2007). Teams, in tegenstelling tot een enkele ondernemer, hebben toegang tot meer menselijke en sociale kapitaalbronnen (Hambrick & D'Aveni, 1992) en de ontwikkelde structuren helpen nieuwe bedrijven om de *liability of newness* te overwinnen (Stinchcombe, 1965). Ondanks deze bevindingen is er een grote variabiliteit tussen nieuwe ondernemingen met betrekking tot de manier waarop zij hun founding team structureren. Dit leidt tot een interessante, maar onderbelichte vraag - wat beïnvloedt de voorkeuren van oprichters ten aanzien van een of ander (mogelijk succesvoller) ontwerp?

Hoofdstuk 4 van dit proefschrift beoogt een bijdrage te leveren aan deze onderzoekslijn door de rol van de persoonlijkheid van de leidende oprichter in de vorming van een ondernemersteam te verhelderen. Gebruikmakend van onze rijke, gedetailleerde gegevens over de functionele rollen en loopbaangeschiedenissen van oprichters, zien we dat de

persoonlijkheidskenmerken van de leidende oprichters verschillende aspecten van de structuur van het oprichtende team beïnvloeden, waarvan bekend is dat ze het succes van nieuwe ondernemingen op lange termijn mogelijk maken. Extraversie, servicegerichtheid en emotionele stabiliteit weerspiegelen de interpersoonlijke aard van het individu en worden geassocieerd met het stichten van een team. Zorgvuldigheid weerspiegelt de afweging en planning van individuen en is belangrijk voor de structurele uitwerking van het oprichtende team.

Hoofdstuk 5: Antecedenten van de rekrutering van managers in hoogtechnologische start-up teams

Nieuwe ondernemingen worden meestal opgericht door een groep vrienden of collega's (Klotz et al., 2014; Ruef et al., 2003), wiens kennis, vaardigheden en charisma de belangrijkste bron van nieuw menselijk kapitaal voor nieuwe bedrijven worden (Beckman & Burton, 2008 ; Eisenhardt & Schoonhoven, 1990). In de loop van de tijd moeten nieuwe ondernemingen hun founding team professionaliseren door nieuwe managers aan te trekken naarmate de onderneming evolueert en de uitdagingen de capaciteiten van de oorspronkelijke oprichters te boven gaan (Boeker & Karichalil, 2002; Chang & Shim, 2015; Wasserman, 2003). Omdat de oorspronkelijke oprichters mogelijk niet over de vereiste vaardigheden beschikken om een bedrijf te leiden dat verder groeit dan het moment waarop het is opgericht, zijn nieuwe managers nodig om de mismatch tussen de capaciteiten van de oprichters en de veranderende vereisten van de organisatie te verminderen. Deze eerste rekrutering op managementniveau is een belangrijke mijlpaal in de ontwikkeling van een nieuwe onderneming, omdat hiermee de koers wordt gezet naar de overgang van een kleine, doorgaans ongestructureerde onderneming die wordt beheerd door een tamelijk informele ondernemergroep naar een volledig ontwikkelde organisatie onder leiding van een professioneel managementteam. Ondanks een aantal studies

die hun aandacht hebben gericht op de evolutie van de oprichtingsteams, weten we nog steeds verrassend weinig over wanneer bedrijven deze mijlpaal bereiken en welke factoren van invloed zijn op de voltooiing ervan.

Het doel van hoofdstuk 5 van dit proefschrift is om bestaande bevindingen over antecedenten van de rekrutering van nieuwe managers te integreren, hun relatieve belang te onderzoeken en aanvullende inzichten te verschaffen. We doen dit met een specifieke focus op hoogtechnologische start-ups met groeiambitie, aangezien deze ondernemingen meestal worden gestart door teams waarin ontwikkeling van capaciteiten bijzonder belangrijk is (Gruber, MacMillan, & Thompson, 2008; Mustar & Wright, 2010). Gebruik makend van onze unieke longitudinale gegevens over 148 Vlaamse, hoogtechnologische nieuwe ondernemingen, vinden we dat de kans dat nieuwe ondernemingen nieuwe managers aannemen afhankelijk is van multi-level krachten die verband houden met het menselijk kapitaal van de oprichtende teams, raad van bestuur en commercialiseringsomgeving.